Faculdade de Engenharia da Universidade do Porto

FEUP

UMBC Energy Usage Analysis and Possible Behavior change

João Carlos d'Almeida Fernandes

Dissertação feita no âmbito do
Mestrado Integrado em Engenharia Electrotécnica e de Computadores

Orientador: Prof. Doutor Marc Zupan e Prof. Doutor João Claro
Co-orientador: Prof. Doutor António R. Moreira

Julho de 2010

U.PORTO

FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

MIEEC - MESTRADO INTEGRADO EM ENGENHARIA ELECTROTÉCNICA E DE COMPUTADORES 2009/2010

A Dissertação intitulada

"UMBC ENERGY USAGE ANALYSIS AND POSSIBLE BEHAVIOR CHANGE"

foi aprovada em provas realizadas em 23/Julho/2010

o júri

Presidente Professor Doutor Cláudio Domingos Martins Monteiro
Professor Auxiliar do Departamento de Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto

Professor Doutor Custódio João Pais Dias
Professor Coordenador do Departamento de Engenharia Electrotécnica e de Computadores do Instituto Superior de Engenharia do Porto

Professor Doutor João Alberto Vieira Campos Pereira Claro
Professor Auxiliar do Departamento de Engenharia Industrial e Gestão da Faculdade de Engenharia da Universidade do Porto

O autor declara que a presente dissertação (ou relatório de projecto) é da sua exclusiva autoria e foi escrita sem qualquer apoio externo não explicitamente autorizado. Os resultados, ideias, parágrafos, ou outros extractos tomados de ou inspirados em trabalhos de outros autores, e demais referências bibliográficas usadas, são correctamente citados.

Autor - João Carlos de Almeida Fernandes

Faculdade de Engenharia da Universidade do Porto

Abstract

The environment has been on the top of the agenda and since renewable energy sources and energy efficiency haven't so far given a solution to the human part of the equation a new solution can be presented and it is behavior change.

This dissertation presents a new methodology. This methodology builds on previous work done by various authors. Geller's work that is based on Azjen's theory of planed behavior developed behavior change methods like the DO IT process. Kaiser that establishes environmental attitude as a powerful predictor of ecological behavior being influenced by a person's environmental motivation and the composite of all the costs involved in the realization of a particular act. Finally, McKenzie-Mohr's contribution that consists on an hybrid combination of psychology and social marketing consists of the evolution of Geller's work.

This method is applied to the University of Maryland. It will follow Geller's DO IT process and respect the various ABC contingencies. We start up with the consumption analysis then with this we are able to create different consumption groups. After having these groups defined we start characterizing these groups and with the information collected adapt the intervention to each singular group. After some time waiting the surveys will enable us to have some insight of how well the intervention is going and with the fluctuation of consumption we will be able to define the proper adaptation to the intervention in order to make a more efficient intervention.

With the results of the practical application of this method we were able to see that this methodology works even if due to the limited time, it was only the first iteration of the method. Limitations were found in the "foot in the door technique" and in the recognition of improvements. This method was limited to the socio-cultural universe that is the state of Maryland. In order to apply anywhere else a new collection of data would be necessary.

Resumo

O ambiente tem estado no topo da actualidade. A mudança de comportamento surge como solução para a dimensão humana do problema, uma vez que as fontes de energia renováveis e a eficiência energética não a têm como objecto do seu estudo.

Esta dissertação apresenta uma nova metodologia, fundamentada em trabalhos anteriores levados a cabo por vários autores. O trabalho realizado por Geller é baseado na teoria do comportamento planeado de Azjen. Geller desenvolveu métodos de mudança de comportamento, como o “DO IT process”. Kaiser, por outro lado, estabelece a atitude ambiental como um poderoso preditor do comportamento ecológico, o qual é influenciado pela motivação ambiental e a composição de todos os custos envolvidos na realização de um acto particular. Finalmente, a contribuição de McKenzie-Mohr consiste numa combinação híbrida de psicologia e marketing social, desenvolvendo o trabalho realizado por Geller.

Este método, ao ser aplicado na Universidade de Maryland, segue a metodologia base de Geller, o “DO IT process” e respeita as diversas contingências ABC. Começa-se com a análise do consumo, e, em seguida, baseados nos resultados prévios, criam-se os diferentes grupos de consumo. Tendo esses grupos definidos, inicia-se a caracterização desses grupos e, com a informação recolhida, adapta-se a intervenção a cada grupo singular. Após algum tempo de espera, a informação recolhida nos inquéritos e a variação do consumo permite avaliar a qualidade da intervenção e definir as adaptações adequadas à intervenção, a fim de efectuar uma intervenção mais eficiente.

Com os resultados da aplicação prática deste método, foi possível constatar que o mesmo é de facto útil; todavia, devido ao tempo limitado, apenas foi possível realizar a primeira iteração do método. Foram encontradas limitações, nomeadamente, no “foot in the door technique” e na capacidade de a população se aperceber das melhorias. Este método é limitado ao universo sócio-cultural que é o estado de Maryland. Se se pretendesse aplicar o mesmo a qualquer outro local, uma nova recolha de dados seria necessária.

Agradecimentos

- Aos meus pais que com os seus exemplos de vida me ensinaram os Valores da Família, do Trabalho e do Respeito pelo outro.
- À FEUP, onde me consciencializei do Saber como um Todo e que o Valor da Verdade Intelectual não tem fronteiras e anda de mãos dadas com o rigor e a exigência.
- À Technische Universiteit Eindhoven onde participei num intercâmbio ERASMUS, o qual, contribuiu muito para o meu enriquecimento humano, científico e cultural;
- À University of Maryland, Baltimore County na qual me encontro a reflectir sobre o meu percurso académico, vincando mais em mim a vontade de todos os meus comportamentos e atitudes serem um contributo constante para o Bem Comum;
- Aos meus amigos, grupo do Colégio Teresiano de Braga e depois da Escola Carlos Amarante, Manuel Miranda, João Miguel, Carlos Ismael, André, Costeira e Ricardo.
- Aos meus amigos da FEUP, agora novos Engenheiros e Engenheiras, que nas nossas actividades profissionais, dignifiquemos a grande Escola de Engenharia da Universidade do Porto e a classe profissional a que temos a honra de pertencer.
- Aos meus orientadores, Professores João Claro e Marcus Zurpan, o meu muito obrigado pelos seus preciosos contributos para a realização deste trabalho.

Acknowledgments

• To my parents with their examples of life taught me the values of Family, Labour and Respect.
• To FEUP, where I become aware of knowledge as a whole and that the Value of Intellectual Truth has no boundaries and goes hand in hand with the rigor and demands.
• To Technische Universiteit Eindhoven where I participated in an ERASMUS exchange, which contributed much to enrich my human, scientific and cultural development;
• To the University of Maryland, Baltimore County, where I find myself reflecting on my academic record, creasing more in me the desire of all my behaviors and attitudes are a constant contribution to the Common Good;
• To my friends, a group of College Teresiano Braga and after school Carlos Amarante, Manuel Miranda, João Miguel, Carlos Ismael, André Correia, Luis Costeira and Ricardo Rocha.
• To my friends at FEUP, now new Engineers, which in our new professional activities, dignify the great School of Engineering, University of Porto and the professional class that we have the honor to belong.
• To my supervisors, Professors João Claro and Marcus Zurpan, my thanks for their valuable contributions to this work.

Página em branco

Index

List of pictures

List of tables

Abbreviations and Symbols

List abreviations (ordenadas por ordem alfabética)

AFS	Affect Scale
EK	Environmental Knowledge
EMSEA	Root mean-square error of approximation
EV	Environmental Values
EBI	Ecological Behavior Intention
FEUP	Faculdade de Engenharia da Universidade do Porto
GEB	General Ecological Behavior
Kg	Kilogram
ME	Measurement Error
MW	MegaWatt
MHh	MegaWatt hour
MJ/yr	Mega joule per year
NIH	The National Institutes of Health
NEP	New Environmental Paradigm
NNFI	Non-normed fit index
PFA	Principal Factor analysis
SD	Social Desirability
S.D.	Standard Deviations
UMBC	University Maryland Baltimore County
UATME	Descrição de Um Acrónimo de Tal Modo Extenso que eventualmente obriga a mudança de linha
USDHHS	United States Department of Health and Human Services
U.S.	United States of America

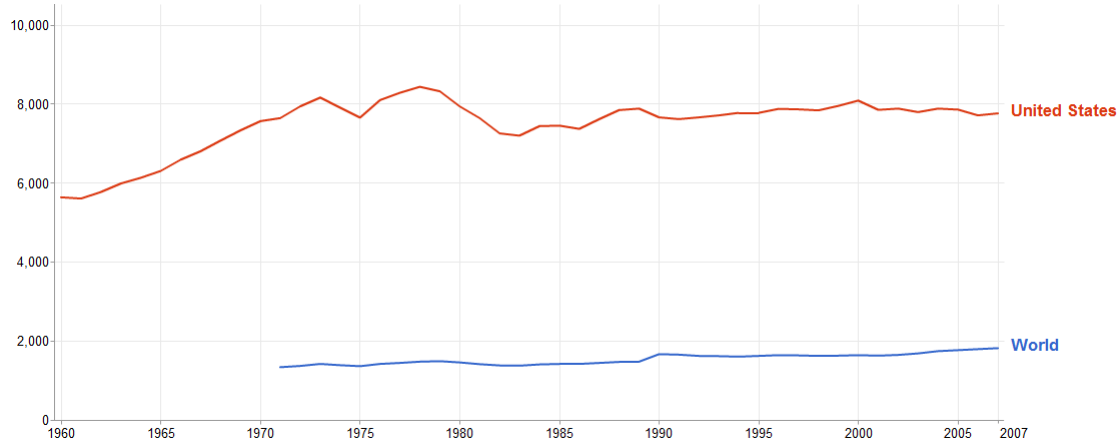
List of symbols

p	Probability
k	Person
i	Behavior
δ_i	Behavior's realization costs
θ_k	Person's commitment
e	Euler's constant (2.718)
$W_{\%}$	Relative energy consumption
W_j	Energy consumption by the building j

Chapter 1 - Reason for this work

1.1 - Introduction

The U.S. energy consumption trends require a dramatic change to diverge from the world's current course towards a significant global climate change. This change must involve the development and adoption of new energy and efficiency technologies as well as changes in social structures, culture, and behaviors. In this work, I bring together a diverse body of research to create an intersection between social theories, current patterns of energy consumption, and practical efforts to enable change. The relationship between society and the environment characterize the role of technology and economic developments in distinct ways that simultaneously celebrate and condemn the direction of our current path into the future are addressed in theoretical frameworks. Most of energy consumption data suggest that even considering that the energy productivity has increased dramatically in many developed countries, the programs focused strictly on the development of energy efficient technologies will not be sufficient to reduce GHG emissions. Instead, social barriers and social mechanisms must be identified and overcome in a series of programs and policies



Picture 1. 1 - Energy use (kg of oil equivalent per capita)[1]

In this project I intend to optimize the way energy is being used on UMBC without requiring any kind of investment in new technologies or any kind of modifications on the

buildings. This project main objective is to save energy spent by the university using behavior change as the main tool.

The work plan is structured as follows:

- I started by describing the reason for this work where, among those there's the Tragedy of the commons (the reason for the unsustainable way that energy keeps being used).
- Historical vision of behavioral change theories.
- Description of UMBC case.
- A more complete description of the three main behavioral change theories is given even if the more complete one is done in appendix 1.
- I give a description of how can the three behavior change theories intertwine and become a more complete method.
- Practical application of the method.
- Analysis of the results seen on the surveys and adaptation of the method in order to improve it.
- Final conclusions of this work.

1.2 - Reason (Tragedy of the Commons)

In order to manage resources like natural food reserves, energy resources (fossil fuels), a clean environment, with clean air, water and soil belong to everyone and yet are protected by no one. Nowadays, protecting such common-pool resources has become a challenge both on a national and global scale.

The ecologist Garrett Hardin, in the 1960s, invoked the analogy of a "commons" in support of his thesis that as human populations increased, there would be increasing pressure on finite resources at both the local and particularly the global levels, with the inevitable result of overexploitation and ruin. He called this phenomenon the "tragedy of the commons." This phrase means that an increase in human population creates an increased strain on limited resources, which jeopardizes sustainability.

The tragedy of the commons can be developed in this way. Consider a pasture open to all. We can predict that each herdsman will try to have as many cattle as possible on the commons. An arrangement like this may work in a reasonable satisfactory way for centuries because tribal wars, poaching, and disease keep the numbers of both man and beast well below the carrying capacity of the land. However when the day of reckoning come, that is, the day when the long-desired goal of social stability becomes a reality. This means following the logic of the commons that tragedy is imminent.

Each herdsman, as any rational being wants to maximize his gain. Explicitly or implicitly, more or less consciously, he wonders of the utility of adding one more animal to his herd? [2] This utility has one negative and one positive component.

Considering that the herdsman receives all the proceeds from the sale of the additional animal and that the positive utility is nearly plus one. The positive component is a function of the increment of one animal.

However, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular decision-making herdsman is only a fraction of minus one. The negative component is a function of the additional overgrazing created by one more animal.

The rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd by adding together the component partial utilities. But this conclusion is reached by each and every rational herdsman sharing a commons. We are presented with the tragedy. Each man is compelled to increase his herd without limit - in a world that is limited. Freedom in a commons brings ruin to all.

In an opposite sense, the tragedy of the commons reappears in problems of pollution. Here it is not a matter of taking something out of the commons, but of putting something in - sewage, or chemical, radioactive, and heat wastes into water; noxious and dangerous fumes into the air. The utility can be calculated as previously. Man rationally can find the cost of waste discharged into to commons to be less than the cost of purifying his wasted before releasing them. As this is considered a general truth, we end up in system of "fouling our own nest"[2],so we end up behaving as rational, independent, free enterprisers.

Considering the tragedy of the commons as a food basket it may partially be averted by private property, or something like it. But the air and waters cannot as easily be limited, and so the tragedy of the commons as a cesspool must be prevented in different ways like, coercive laws or taxing devices that make the utility of polluter higher to treat his pollutants than to discharge them untreated. The owner of a factory near a stream usually finds it difficult to understand why it isn’t his natural right to muddy the waters flowing past his door. As the law is constantly behind the times, we can see that it requires adapting to its newly perceived aspect of the commons. So being pollution a problem directly correlated to population, as population becomes denser, the natural recycling (chemical and biological) creating a need for a redefinition of property rights.

This is why behavior change appears as such a good solution since it will be affecting the consumption but also as the way people think about consumption.

1.3 - Behavioral change theories

Behavioral change theories and models were made in order to explain the reasons behind alterations in individuals' behavioral patterns. These theories determine the major

behavioral factors as environmental, personal, and behavioral characteristics. Recently, an increasing interest in the application of these theories in various areas like: health, education, and criminology. Hoping that with this understanding of behavioral change will end up improving the services offered in these areas.

1.3.1. History

Most of the major theories that are outlined in many of the original works that were published in the 70s and 80s are the basis for current knowledge about behavioral change theories. There are example like: Icek Ajzen's articles on the Theories of Reasoned Action and Planned Behavior, Albert Bandura's writings on Social Cognitive Theory, and James Prochaska and Carlo DiClemente's works on the Transtheoretical Model. Recently the interest in behavioral change theories has arisen due to their apparent application in areas like health, education, and criminology.

1.3.2. General theories and models

The various behavioral change theory or models focuses attempt to explain behavioral change with different factors. The most recognized are the Learning Theories, Social Learning Theory, Theories of Reasoned Action and Planned Behavior, and Transtheoretical Model. Some specific elements of these theories , especially elements like self-efficacy that are common on several of the theories have been researched on.[3]

1.3.3. Self-Efficacy

Self-efficacy was defined as an individual's idea of their own ability to perform a task. This idea is factored with the individual's prior success in the task or in related tasks, the individual's physiological state, and outside sources of persuasion [4]. It's thought that self-efficacy can be predictive of the amount of effort an individual will expend in initiating and maintaining a behavioral change, so even thought that self-efficacy is not a behavioral change theory per se, it's an important element of many of the theories like the Theory of Planned Behavior [4] .

1.3.4. Learning Theories/Behavior Analytic Theories of Change

the Learning Theories originated with behaviorists like Burrhus Frederic Skinner, that stated that complex behavior is learned gradually through the modification of simpler behaviors (USDHHS 1996). These theories, value greatly imitation and reinforcement stating that individuals learn by duplicating behaviors they observe in others and that rewards are essential to ensuring the repetition of desirable behavior (Skinner 1953). In order to develop complex behaviors, imitation and subsequent reinforcement of simple behaviors is needed. Then as verbal behavior is established, we can learn through rule governed behavior and thus not all action needs to be contingency shaped.

As Skinner (1957) was one of the first psychologists that recognized the critical role of imitation (what he termed "echoic behavior") in the learning of language.[1]. Various behaviors analytic theories of change have effectively improved the human condition (see behavior modification, behavior therapy and applied behavior analysis).

1.3.5. Social Learning/Social Cognitive Theory

Based on Social Learning Theory, also known as the Social Cognitive Theory, behavioral change is influenced by environmental, personal, and behavioral elements, being each factor affected by each of the others. For example, as we saw in the principles of self-efficacy, one person's behavior is affected by his thoughts and his characteristics cause certain responses from the social environment. In the same way, the environment affects the development of personal characteristics as well as the person's behavior, and an individual's behavior may affect the environment as well as the way the individual thinks or feels. Focusing on the reciprocal interactions between these factors, Social Learning Theory hypothesized to determine behavioral change (Bandura 1989).

1.3.6. Theory of Reasoned Action

According to the Theory of Reasoned Action an individual considers the consequences before performing a particular behavior. Consequently, intention is important in order to determine behavior and behavioral change. As Icek Ajzen [3] defended, intentions develop from an individual's perception of a behavior as positive or negative together with the individual's impression of the way their society perceives the same behavior. Thus, personal attitude and social pressure shape intention, which is essential to performance of a behavior and consequently behavioral change [3].

1.3.7. Theory of Planned Behavior

The Theory of Planned Behavior was in 1985, by Ajzen expanded upon the Theory of Reasoned Action, which emphasizes the role of intention in behavior performance but also enables to cover cases in which a person is not in control of all factors affecting the actual performance of a behavior. In this way, in this new theory it's stated that the incidence of actual behavior performance is directly correlated to the amount of control an individual possesses over the behavior and the strength of the individual's intention in performing the behavior. In his article, Ajzen[3] further hypothesizes that in order to determine the strength of the individual's intention to perform a behavior self-efficacy has great importance.

1.3.8. Transtheoretical/Stages of Change Model

As the Stages of Change Model, also known as Transtheoretical Model, states that behavioral change is a five-step process. This five stages, that people go thought before achieving complete change, are precontemplation, contemplation, preparation, action, and

maintenance (USDHHS 1996). At the precontemplation stage, an individual may or may not be aware of a problem but has no thought of changing their behavior. From precontemplation to contemplation, the individual starts to want to change a behavior. During preparation, the individual as the intention to change the behavior within a near future, and during the action stage, the individual begins to act accordingly to the new behavior. An individual finally enters the maintenance stage once they exhibit the new behavior consistently for over six months ("Behavior Change" 2007).

1.4 - UMBC Case

The total energy usage is in terms of ANNUAL energy consumption in general, UMBC uses about:

Energy	MJ/year
fuel oil	4,39E+06
electric	2,77E+08
natural gas	2,64E+08
Total	5,45E+08

Table 1. 1**- Annual energy consumption**

The reason of this work is to show that there is a lot of energy that is being wasted and where is it being wasted. And with a minimal investment contain the waste.

Psychology has a central role to play in speeding the transition to a sustainable future, because a central aspect of sustainability is widespread behavior change. To date, however, most programs promoting sustainable behavior have featured information-intensive campaigns that make little use of psychological knowledge. Community-based social marketing is an attractive approach in which promoters identify the activity to be promoted and barriers to this activity and then design a strategy to overcome these barriers, using psychological knowledge regarding behavior change. The strategy is piloted to test it's a broader scale. Unlike many information-intensive campaigns, community-based social marketing has been shown to have a much greater probability of promoting sustainable behavior. Tow case studies are provided to illustrate the approach and its possible results. *"That which is not good for the beehive cannot be good for the bees"[5]*

Chapter 2 - **Background**

In this chapter I'll present the three most important and more consistent perspectives on the process of behavior change. Each of them presents its advantages and at the same time their flaws.

For instance, Geller Theory show a lot of promise as a group of processes that actually are easy to implement, but on the other hand the interface between collected data an actual intervention is weak so it's needed an more complex and complete method like the one presented by Kaiser where the data collected organized but also there's a way to predict the influence of a certain intervention (thanks to Kaiser's adaptation of Rasch model).

Finally, McKenzie-Mohr isn't actually a process to change behavior, but ends up being a good way to determine the obstacles and difficulties that would appear as a result of various and many reasons during any kind of intervention. Also thanks to his work done based on Geller's method we can use some more refined and recent techniques

A more complete description and explanation of all methods can be found in annex 1.

2.1 - Geller Theory

2.1.1. Motivation

In the "Handbook of Environmental Psychology" Geller admitted while many utility companies push conservation they don't apply the most effective behavior change techniques defined by research. Likewise, water suppliers and municipalities periodically ask residents to avoid certain water wasting behavior; but such requests are usually reactive (i.e. when water shortage is imminent) rather than proactive, and it seems strategic applications of behavior analysis techniques are rare except for education, prompting, and policy enforcement. It's encouraging that most major appliances are sold with an "energy Guide" but the impact of these "activators" could be significantly enhanced if behavior analysis and self management principles had been considered when they were designed.

2.1.2. Rationale

There are many possible reasons for the failure of these behavioral community studies to cause a visible impact on environmental preservation. One of the most obvious things is the limited audience of these demonstration projects. Most of the cases the research is published in professional journals and books read almost exclusively by other psychologists. Even considering the convincing demonstrations of the efficacy of their behavior change techniques they are given to people that have little interest or even influence in a possible large-scale dissemination and application. In other words, the critical social marketing aspects of behavior change technology have not been addressed [6].

Bailey comments on this dissemination problem:"We have a great science (the experimental analysis of behavior) and a pretty good technology (applied behavior analysis) but no product development or marketing"[7] and have "neglected to develop socially acceptable terminology for presenting our concepts to consumers… we have, in our zest for science and technology, taken the human concerns out behavior analysis". [7]

Regarding the design of behavior change interventions, Boyce and Geller were able to reach the following conclusion from their comparison of behavior-based interventions that resulted in substantial versus minimal behavioral maintenance:

- Reward schedules that are just sufficient to initiate behavior change are more likely to produce longer-term behavior change than more powerful rewards.
- Global or general representations of desirable behavior results in more behavioral maintenance than references to specific behavior.
- Behavioral commitment strategies accompanied by information regarding the rationale for performing a target behavior can have a long term effect.

Principles:

1. Focus intervention on observable behavior
2. Look for external factors to improve performance
3. Focus on positive consequences to motivate desired behavior
    a. ABC contingency :
        i. A-> activator
        ii. B->behavior
        iii. C->consequence

2.1.3. Description

The DO IT process is a general behavior analysis method for solving the behavioral dimension of environmental sustainability. It provides objective data for exploring why certain environment-destructive behavior. If an intervention does not produce a desired effect, it is either refined or replaced with a completely different behavior change approach.

"D" for define:

Behaviors:

>environment protective/destructive
>One time efficiency behavior/curtailment behaviors

"O" for observe:

This stage the objective isn't to find faults but to find the facts, this process ends up facilitating the discovery of best behaviors and conditions that need to be changed or continued in order to protect the environment

"I" for intervene:

In this stage interventions are designed and implemented in order to increase pro-environment behaviors or decrease environment-destructive behavior.

Consequences of Environmental Protection-Skinner(1987) claimed that behavior is determined by its consequences, and that we shouldn't expect many people to modify their behavior as a result of information or advice alone(i.e. activators) especially when information pertains a distant future.

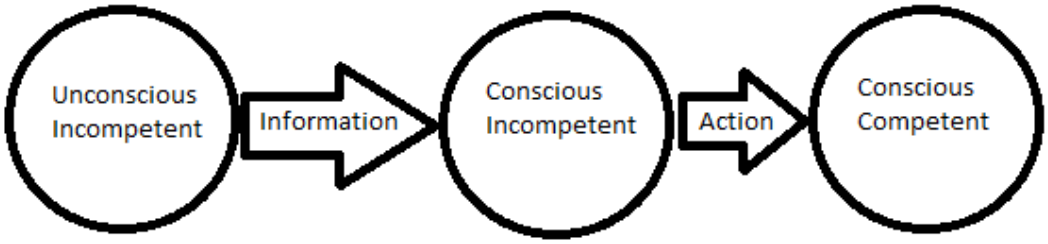
Rewards vs Penalties-Incentives and disincentives are activators that announce the availability of rewarding or penalizing consequence.

Types of Rewards Contingencies-The reward contingencies implemented for environmental sustainability have been diverse. Some rewards have been given after the performance of a desired target behavior, whereas other rewards have been contingent upon a particular outcome.

Feedback Techniques-Most of the feedback research for environmental protection addressed residential energy consumption and the feedback was usually given to residents (e.g. reviews by Shippee [8]; Winett [9]).

"T" for test

In the test phase of the DO IT process, information needed to refine or replace a behavior is provided. If in the behavioral observations, during this phase indicate a lack of significant improvement in target behavior, the behavior change agents analyze and discuss the situation, and then refine the intervention or chose another intervention approach.



Picture 2. 1- The three Stages of behavior

Three Basic Intervention Approaches:

Both the activators and the consequences of the ABC contingency as previously described are in principle external to the performer, or internal (as in self-instructions or self-recognition). A task's activators and consequences can be intrinsic or extrinsic, which means that direction or motivation is provided naturally as a behavior is performed, or it's added to the situation extrinsically in order to improve performance. A program with incentives and/or rewards is external and extrinsic. In order to direct and motivate a desirable behavior an activator and a consequence are added to the situation. [10]

Instructional Intervention

Instructional intervention consists of a planned set of procedures that are aimed at teaching a specific set of academic or social skills. An intervention ends up being more than a single lesson and less than an entire curriculum. The base characteristics of an intervention would be:

1. It is *planned.* Planning implies a decision-making process. Decisions require information (data) therefore; an instructional intervention is a data-based set of teaching procedures.
2. It is *sustained.* This means that an intervention likely is implemented in a series of lessons over time.
3. It *targets*, or is *focused* on, a particular student or students and on a particular set of skills or knowledge. This means an intervention is intended to meet a specific set of needs for a student(s).
4. It is goal *oriented.* This means that the intervention is intended to produce a change in knowledge/behavior (academic or social) from some beginning or baseline state toward some more desirable goal state.
5. It is typically a *set* of procedures rather than a single instructional component/strategy. Interventions typically address a range of ICEL considerations. For example: Instruction (e.g., pace, guided practice); Curriculum (e.g., correct level of difficulty, sequence); Educational Environment (e.g., allocation of instructional time or arrangement of instructional setting); and Learner (e.g., motivation patterns or prior knowledge of task).

6. Re-administering performance probes for progress monitoring is *NOT* an intervention.

Intervention Target(s)	Reason for intervention
• What will you teach? State Objective • What kind of information is it • Are all components of an objective stated? • Is an aim date specified? • Is "Fair pair" rule followed?	• Have a rationale for each intervention or component. • Alignment • Previous assessment data • Current specific-level assessment data
Specific Intervention Activities	Evaluation Procedures
• Materials • Time allocated • Instructional method • Compatibility with high-impact variable(e.g., ecology) • Performance monitoring procedures.	• How will you know if your instruction is effective? • What data rules will be applied?

Table 2. 1- **Instructional intervention**

Supportive Intervention

In order to turn the right way to do something into a natural routine, practice is important. The repetition of an action leads to fluency and, frequently, to automatic or habitual behavior. This is a state that is really useful in repetitive actions like the curtailment behaviors that need to be determined, but practice can benefit greatly from supportive intervention even if it does not come easily. Support and reassurance is needed in order for us to know that we are doing the right thing and to encourage us to keep going.

While instructional intervention consists primarily of activators, supportive intervention focuses on the application of positive consequences. Thus, when we give people rewarding feedback or recognition for particular behavior, we are showing our appreciation for their efforts and increasing the likelihood they will perform the behavior again. Each occurrence of the desired behavior facilitates fluency and helps build a good habit [11].

Motivational Intervention

Usually motivational intervention is required when people know what to do but do not do it. This means that they require some external encouragement or pressure to change. Instruction alone is obviously not enough because they are consciously doing the wrong thing. Geller refers to this as a "Calculated risk". [11]

Usually, when we usually perform calculated risks it's because we see the positive outcome of the at-risk behavior to be of greater value than the negative consequences. This happens because the positive outcome like comfort, convenience, and efficiency are immediate and certain, while the negative consequence of at- risk behavior (such as Green house effect, raise of the price of oil) is a possibility and seems remote. Also there's the fact

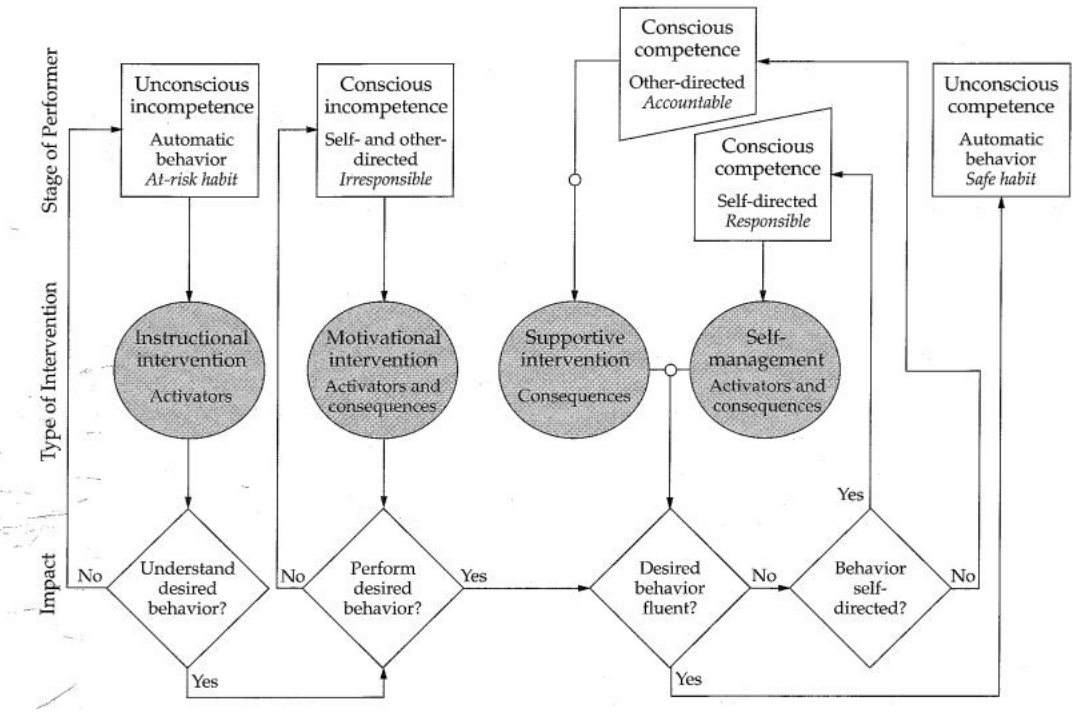
that the safe alternative is relatively inconvenient, uncomfortable, or inefficient, and these negative consequences are immediate and certain.

This ends up being when an incentive-reward program is useful. Such a program attempts to motivate a certain target behavior by promising people a positive outcome if they perform it. The promise is the incentive and the consequence is the reward.

2.1.4. Strengths and limitations

Usually, governments use disincentives and penalties to promote environment-preserving behaviors. They in order to protect the environment frequently use ordinances or laws (e.g., fines for littering, illegal dumping, or using excessive water or for polluting land, water, or air); and to be effective, these disincentive/penalty interventions usually require extensive promotion (activators) and enforcement (consequences). This approach has been de-emphasized mostly because negative effect, feelings, or attitudes typically accompany attempts to mandate behavior change through disincentive/penalty tactics.

When we link a positive attitude with a change in behavior, odds are that the desired behavior will end up being a social norm. Positive attitudes are more likely to follow an incentive/reward approach than a disincentive /penalty intervention because the former approach is more likely to be perceived as “voluntary” and no threat to individual freedom[12].In fact, perceiving a threat to one’s freedom can lead to behavior contrary to compliance with a mandate[13].



Picture 2. 2- The flow of behavior change model helps to match intervention approach with needs of the target individual(s) [6]

2.2 - Kaiser Theory

2.2.1. Motivation

In most modern societies saving energy and decreasing consumption have become pressing matters. In order to help environmental policy-makers, psychology must prove itself in a way that it effectively helps decisions without providing useless information. The decision support system is based on quantitative empirical evidence and not in intuitions.

Nowadays psychology hopes to develop a way to decrease the exploration of earth's natural resources as a result of the environmental problems of the decrease of natural resources. [14];[15]

Kaiser defends that theoretical knowledge may eventually guide a campaign, but only after policy-makers have decided to adopt a motivation promotion strategy. He defends that most of policy-making involves decisions about rather basic issues. And hopes, to leave the specifics of a campaign, be it a legislative, a monetary, or an educational one, to the promotion experts.

Since psychologists usually refer to individual behavior rather than to behavior of whole societies they ask questions such as what determines an individual's (ecological behavior i.e.)

actions that work towards environmental preservation and/or conservation' [16] or how can behavior be changed in a more ecological direction. In answering these questions, environmental attitude is considered one of the most promising concepts [17]. In fact, almost two-thirds of all environmental psychological publications include environmental attitude in one way or another.

Environmental attitude and ecological behavior have a well-explored relationship.

Kaiser establishes environmental attitude as a powerful predictor of ecological behavior. Up until his study most failed to establish the relationship because they did not consider three shortcomings that limit the predictive power of environmental attitude concepts:

1) the lack of a unified concept of attitude
2) the lack of measurement correspondence between attitude and behavior on a general level
3) the lack of consideration of behavior constraints beyond people's control

Based on Ajzen's[18] theory of planned behavior, Kaiser's study uses a unified concept of attitude and a probabilistic measurement approach to overcome these shortcomings. Data collected from members of two different Swiss transportation associations are used. Kaiser ended up confirming three measures as orthogonal dimensions by means of factor analysis:

1) environmental knowledge
2) environmental values
3) ecological behavior intention

2.2.2. Rationale

As it was previously said Kaiser identified past studies shortcomings:

1) the lack of a unified concept of attitude
2) the lack of measurement correspondence between attitude and behavior on a general level
3) the lack of consideration of behavior constraints beyond people's control

Based on Ajzen's [19] theory of planned behavior, the Kaiser's study uses a unified concept of attitude and a probabilistic measurement approach to overcome these shortcomings. Kaiser confirmed three measures as orthogonal dimensions by means of factor analysis: environmental knowledge, environmental values, and ecological behavior intention.

One other measure, general ecological behavior, is established as a Rasch-scale that assesses behavior by considering the tendency to behave ecologically and the difficulties in carrying out the behaviors, which depend on influences beyond people's actual behavior control. A structural equation model was used to confirm the proposed model: environmental knowledge and environmental values explained partially the variance of ecological behavior intension which, in turn, predicted another fraction of the variance of general ecological behavior.

The key to such a system is a measurement instrument in which environmental motivation becomes tangible in individual actions. In this article, we provide empirical examples of such a decision support system in the environmental domain. It consists of (a) evidence about environmental motivation of persons, (b) evidence about motivation's spatial distribution, (c) knowledge about the socio-cultural conditions that affect individuals when they translate motivation into action (i.e. structural information), and (d) a forecast of the environmental impact—the concrete conservation potential of various behaviors.

Kaiser in his article gave a special importance to the fact that nowadays even people that want to contribute to the environment their contributions are dependent to the level of effort they imply. In this way he meant that, within the various contributions for the environment like, using the bike for commuting, not using the drier or not using detergents. This means, each behavior has implied in itself a certain degree of effort or expenditure of certain personal resources (time, money, space, or even resist social pressure). Considering that people have options this means that each one will take into consideration the options he has and find his own optimal solution.

Kaiser's use of Rasch model was defined as a function of two factors and those were:

a) a person's environmental motivation

b) the composite of all the costs involved in the realization of a particular act

Kaiser and colleagues have shown that the "Rasch model" mathematically describes this functional relationship adequately (e.g. [20]; [21]).

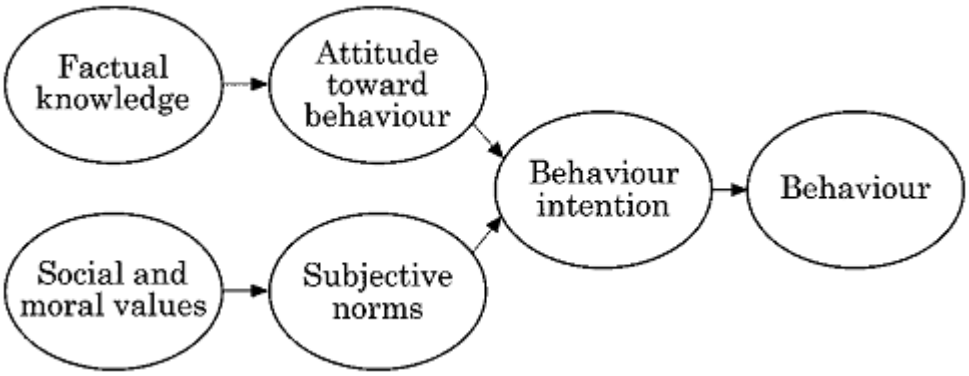
2.2.3. Description

In the theory of reasoned action [22]and in its more recent iteration, the theory of planned behavior [3], the intention shown to perform the behavior in question is considered the precedent the actual behavior. On the other hand, intention, is related to the attitude towards performing a particular act and subjective norms (i.e. the perception of the expectations of relevant others). Since attitude involves not only the evaluation of the results but predicting the odds of the result occurring, salient information or factual knowledge is a necessary precondition for any attitude [23]. As subjective norms are related with both the strength and the motivation to comply with normative beliefs, like social and moral values (i.e. what are the expectations both social and moral, which would be the prediction of the targets' subjective norms).

In picture 3, there's a graphical representations of the theory of planned behavior includes the theory of reasoned action because it takes in to account influences on behavior that transcend people's control. If the impact determined through the idea of control, we have to take for granted two propositions:

1) the predicted behavior must be, at least partially, beyond volitional control
2) perception of control must reflect actual control upon behavior with some accuracy [24]

While the latter proposition can be seen as a flaw on the planned behavior approach, the first is often defended in the ecological domain.



Picture 2. 3- The theory of reasoned action

Following the factor loadings of the PFA, the environmental attitude related scales EK, EV and EBI were divided into two balanced sub 10 scales EK1, EK2, EV1, EV2, EBI1, EBI2 that were used as input variables for the structural equation analyses. After further analysis Kaiser concluded that the reliability of the indicators was different. For example, the reliability of EV2 turned out to be quite low see Figure 2.

All structural equation models were assessed using the Maximum Likelihood method cf. Joreskog & Sorbom, 1993 [25]. Unless otherwise indicated, the correlation matrix was used as the input matrix. See Appendix 2 for the correlation matrix, variable x means M, and their standard deviations (S.D.).

The function that represents the Rasch model is:

$$p(x_{ki} = 1|\theta_k,\delta_i) = \frac{\exp(\theta_k - \delta_i)}{1 + \exp(\theta_k - \delta_i)}$$

Following the Rasch model the variables are called:

p->Probability

k->Person

i ->Behavior

δ_i->Behavior's realization costs

θ_k->Person's commitment

e-> Euler's constant (2.718)

We should take into consideration the fact that in this model, people's environmental motivation and behaviors are taken into account. In other words, this model enables us to predict the odds or the level of acceptance of a certain behavior. This can be used both in small or big scale.

Since the Rasch model takes into account just one parameter, only analyses the behaviors on considering the importance given by the persons. So we can pick up what is considered as an individual environmental motivation and re-state it as a list of behavior means that a group of persons actually uses to achieve the conservation goal. We can only make this list if the realization costs of a behavior are taken into account which gives us the level of popularity of an action and we need to assume that everyone will be influence in a similar way. Kaiser took a series of tests where he determined if Rasch models axioms could be taken trusted in his case and achieved some interesting results and conclusions. *According to this misconception, the behavior relevance of individual motivation is anticipated to depend on the behavioral costs involved* (e.g. [26]).

2.2.4. Discussion

Kaiser also gave a certain degree of importance not only to the motivational part but took into consideration the subjective influence on decisions [27], so, the socio-cultural circumstances will in an uncertain way influence the results of the intervention. This means that it can be done if differential realization costs are taken into account in the determination of the environmental motivation of people. He had success in proving this with different sets of behaviors (e.g. [28]; [29]).

"Until now, this research has shown that under fairly similar conditions environmental motivation translates into an array of more or less preferred behaviors and, thus, a range of behavioral costs that individuals must overcome in a systematic manner in their efforts to accomplish their personal conservation goals."[27]

When people are deliberating if they are going to act, the realization costs are taken into account, even more, this costs affect everyone.

This means, the preferred behavioral means to achieve the conservation goal can only be used within similar conditions, in other words this conditions aren't easily transposed to other countries(e.g. [28]; [27]).

We can see that it's easy to not use a car in a Swiss Urban environment on the other hand if you are in Sweden it's not that easy to make that choice. Another example, is heating and consumption in Central and Southern Europe differences.

In other words, when persons are exposed to highly incomparable obstacles and opportunities, which are imposed on them by the socio-cultural, geopolitical, and/or climatic conditions, the consequence is variation in preference for behavioral means according to these realization conditions.

2.3 - McKenzie-Mohr

2.3.1. Motivation

Fostering sustainable Behavior Through Community-Based Social Marketing

Psychology has a central role to play in speeding the transition to a sustainable future, because a central aspect of sustainability is widespread behavior change. To date, however, most programs promoting sustainable behavior have featured information-intensive campaigns that make little use of psychological knowledge. Community-based social marketing is an attractive approach in which promoters identify the activity to be promoted and barriers to this activity and then design a strategy to overcome these barriers, using psychological knowledge regarding behavior change. The strategy is piloted to test it's a broader scale. Unlike many information-intensive campaigns, community-based social marketing has been shown to have a much greater probability of promoting sustainable behavior. Tow case studies are provided to illustrate the approach and its possible results.

"That which is not good for the beehive cannot be good for the bees" – Marcus Aurelius [5]

2.3.2. Rationale

In Canada, people developing programs to promote sustainable behavior are increasingly using a hybrid combination of psychology and social marketing (see Geller[30] for an earlier integration of psychology and social marketing).

In contrast to the conventional approaches just reviewed community-based social marketing has been shown to be quite effective at fostering sustainable behavior([31]).Its effectiveness is due to its pragmatic approach, which involves the following steps: carefully selecting an activity to be promoted; indentifying barriers to the activity; designing a strategy to overcome these barriers, when possible; piloting the strategy with a small segment of a community; and finally; evaluating the impact of the program once it has implemented across a community.

2.3.3. Description

2.3.3.1 Identifying Barriers

Barriers to an activity can be internal to an individual (e.g., lack of knowledge of how to install a programmable thermostat) or outside the individual (e.g., absence of convenient mass transit system), Further, multiple barriers may exist for any activity, and these barriers appear to be activity specific [32]; [33].For example, what precludes someone from installing additional insulation in his or her attic is quite different from what prevents his or her installation of a programmable thermostat or participation in backyard composting. Consequently, the development of an effective program needs to begin with identifying barriers. This is true for one simple reason: It is difficult, if not impossible, to design an effective program to promote an activity without first knowing what inhibits the public from engaging in the activity to be promoted. Yet, this step is often skipped. In an evaluation of Canadian environmental programs, reviewers found that most program developers had neither determined the environmental impact of the behavior to be promoted nor investigated the barriers to that activity[31].As a result, in many of the cases in which barriers had not been identified, the delivered program produced little or no behavior change.

2.3.3.2 Designing Programs

Once barriers have been identified and prioritized, it is possible to develop a sound social marketing strategy to overcome those barriers. For example, barriers to proper tire inflation were identified through a national survey of Canadians ([34]).Data such as these make the development of a sound strategy substantially easier. By identifying and prioritizing barriers to tire inflation, the program designers were able to propose a strategy to overcome these barriers that had a much higher likelihood of success than if this preliminary research had not been conducted.

The development of a sound strategy depends on carefully identifying ways to overcome the important barriers. In the above case , the fact that memory was the most important factor in distinguishing frequent from infrequent tire checkers suggested that prompts as gas stations. Reminding motorist to check their tires and providing information on how to do so – might significantly increase tire checking. (In particular providing women with this requisite knowledge would be vital).further, because the lack of a tire gauge was significantly related to motorists not checking their tires, having gas stations lend tire gauges to customers might overcome this barrier.

2.3.4. Discussion

A pilot study allows program designers to test various strategies against one another to determine the most cost- effective strategy, to refine a strategy until it works effectively, and to avoid costly expenditures by not implementing ineffective programs that will have little or no return on investment. Additionally, performing a pilot can return on investment. Additionally, performing a pilot can be an essential step unconvincing funders that a program is worth supporting.

Evaluation is the final component of a community based social marketing strategy. In evaluations, measure of behavior change or consequences of behavior change (e. g., reduced residential energy use) are preferable over indirect and less reliable measures, such as self. Reports or increases in awareness. Evaluation studies can provide information that is valuable for further funding.

Important websites:[35],[36]

2.4 - Conclusion

Although a cornerstone of sustainability is behavior change, it has yet to make a major contribution to the design and delivery of programs to foster sustainable behavior. Not only can psychologists assist with program design and evaluation, but they can also provide reliable information regarding barriers to activities.

All this methods, in their way, can contribute for a more complete method.

We can start with Geller theory as the skeleton for the method where the DO IT process will be the back bone of the process. And considering that all were based on Ajzen early works we can see they all have something in common.

Now, the resources that Kaiser Theory gives, not only, enable us to distinguish the behavior intentions, from actual behaviors, but also we can measure then and predict them.

Finally, McKenzie-Mohr consists of a more recent iteration on the Geller theory where the behaviors, barriers are identified more easily and the programs are designed with a more recent and up to date concepts of psychology and Social Marketing

Chapter 3 – **A New Approach to Energy Use Behavior Change**

This final model represents the intervention that will take place. This method is not a final and static process it's a model that thanks to the feedback we'll receive thanks to the consumption and the surveys will be always improving and adapting.

Since this model won't be following the structure of Geller, McKenzie-Mohr or even, Kaiser I think this will end up making a more complete and flexible to all realities being those an American university or any other kind of place.

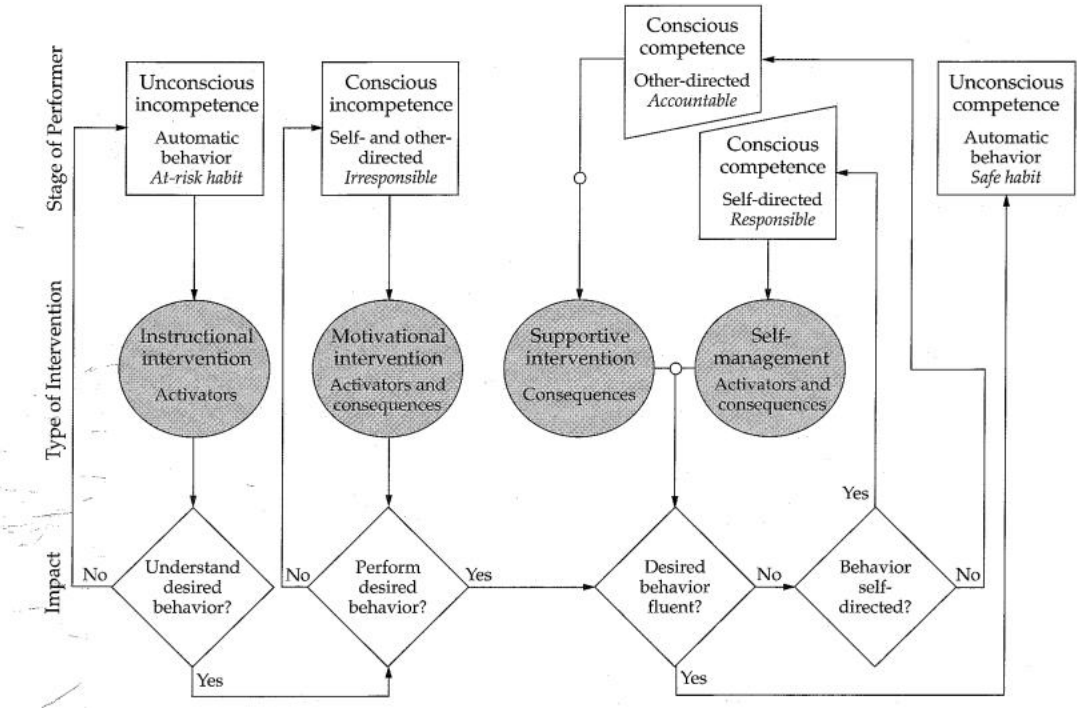
3.1 – Overview

This method as any other method that involves behavior change needs a social background base. In order to take into consideration the way people will react to interventions and how much the intervention is needed.

After this, there's a need to define the targets not only, the behaviors but also we need to sub-divide the targets into groups that can be considered individual and that at the same time we can predict the outcome of the intervention with a certain level of uncertainty.

Now it's down to influencing each of the sub-groups and the interventions can both be very similar or very different from group to group. They should be adapted to each individual influence that is possible to create in order to achieve the desired results.

We can see that this intervention actually ends up being very similar to Geller theory but the scope of the intervention is altered because the each group is submitted to this intervention.



Picture 3. 1- The flow of behavior change model helps to match intervention approach with needs of the target individual(s)[6]

Now the intervention needs to be set to a specific kind of population and key information is needed. Having taken this in consideration the easier way to obtain it is to make a survey.

This survey not only will return the predisposition of each population for the intervention but how much each of the interventions is needed.

Considering that Geller's model is a little bit out dated the intervention won't be divided in fazes but actually will be a group of instructional, motivation and supportive interventions. All these interventions will be made differently to each groups according to the results of the survey but most importantly It will be managed but surveys that would be done in order to determine the self-management part.

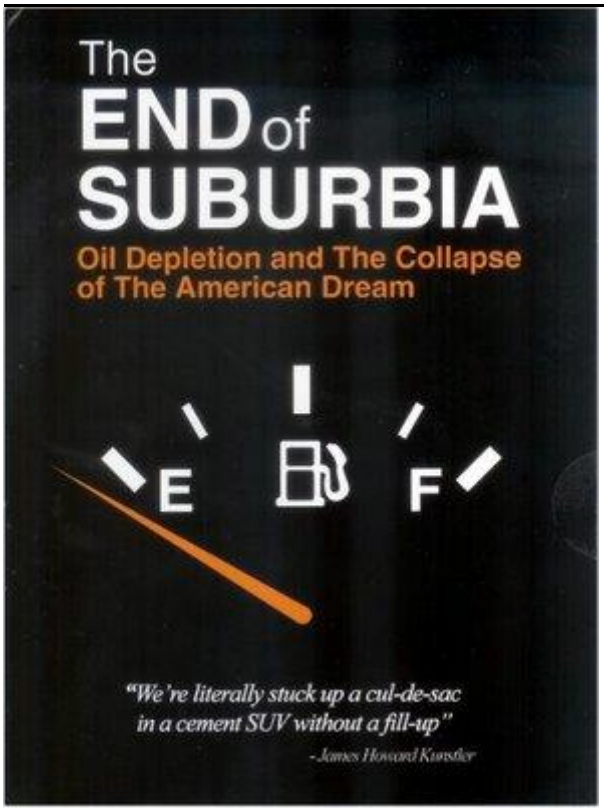
3.2 – Background information for the intervention

First of all before defining the behaviors analyzing Kaiser's article I was able to pin point a specific intervention that should be made and that is:

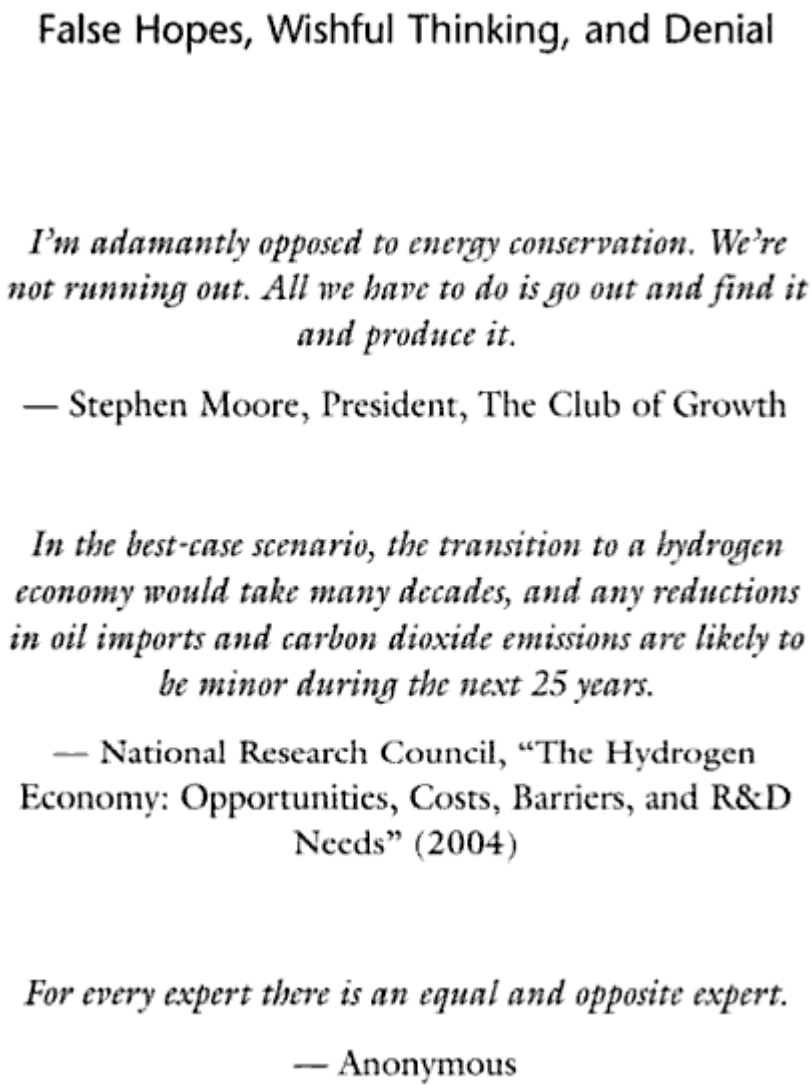
3.2.1. Country-Specific Realization Conditions

As it was previously explained human actions aren't exclusively subjective, in other words, not motivationally relevant [27], so the outcome of the intervention needs to be customized in order to accommodate the socio-cultural circumstances.

American Socio-cultural Circumstances (energy wasting perspective):



Picture 3. 2- The end of suburbia[37]



Picture 3. 3- From Powerdown: options and actions for a post-carbon world from Richard Heinberg[38]

First I'll start by pointing out as an example the American dream that has mainly two basic payoffs:

1) work hard and you will be justly materially rewarded
2) your kids will do better materially than you, as you did better than your parents

This means that as long as you work hard you can "always" enjoy the perks of being successful. But in truth, keeping this pace we can see that resources like oil are finite so this means that even if we can we shouldn't spend energy and other commodities because it's the futures that we are putting at stake.

So thanks to this part of my method I was able to define the area that is going to be essential in order to start any kind of intervention, and at the same time a good motivator for any kind of behavior change.

Now we can apply the ABC contingency where since we know what is the activator we will only need the behavior (in this case a group of behaviors) and the consequences of them.

3.2.2. Definition of target of intervention

Having defined the ABC contingency, we will need to know, what the target of the intervention is. In other words, who and how to intervene.

In this method there will be a screening for groups of people. Then, these groups of people will be placed in their level of importance.

These levels of importance are essential, since the success of the intervention is not measured if the target people change their behaviors. It's measured by the drop in energetic consumption of the university.

For this kind of grading I used an instrument that is the Pareto diagram. With this diagram I was able to define the contribution of each group of people for the oscillations of consumption in the whole university.

This diagram was complemented with a certain level of reasoning because since the intervention will be mainly turned into behavior change, buildings and groups of people that spend energy independently to behavior will be simply ignored.

3.3 - Definition of the kind of behaviors

Considering that the groups of intervention are defined (according to the DO IT process), after there will be a need to define then observe intervene and finally test.

I start by the definition, on each group there will be one or more behaviors to be changed, and there will be cumulative effect on this method I present since my intention is to affect the whole university.

So in the definition, I'll try to act on curtailment behaviors and on one time efficient behaviors. This means that on the short time the behaviors will be more energy efficient but also on the long run the machinery on the university will end up by being more efficient.

On the observation time I took into account not only the Geller theory background needs but also McKenzie-Mohr's requisistes this means that not only did I discovered the best behaviors and conditions that need to be changed or continued in order to increase the energy efficiency on UMBC but also I took into account the barriers.

The intervention was the trickiest part, this is so because, in this method there wasn't a single behavior intervention but actually a mix of the advised interventions that McKenzie-Mohr and in a format that would enable me to measure it's effectiveness with Kaiser's theory.

This means that each kind of intervention was made in a way that it could be individualised so that the results of the feedback would be enough to make it possible to addapt each of the interventions to the respective survey(feedback and cyclical evolution of the method).

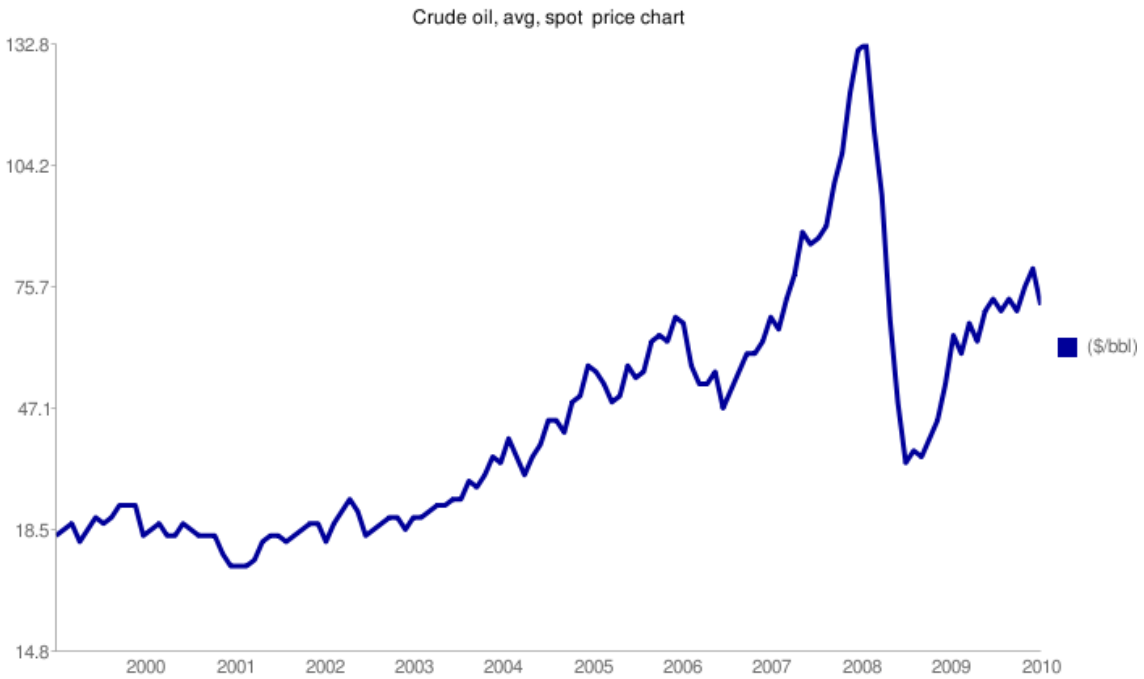
Chapter 4 – **Method application at UMBC**

4.1 - Analysis of motivation for change of behavior

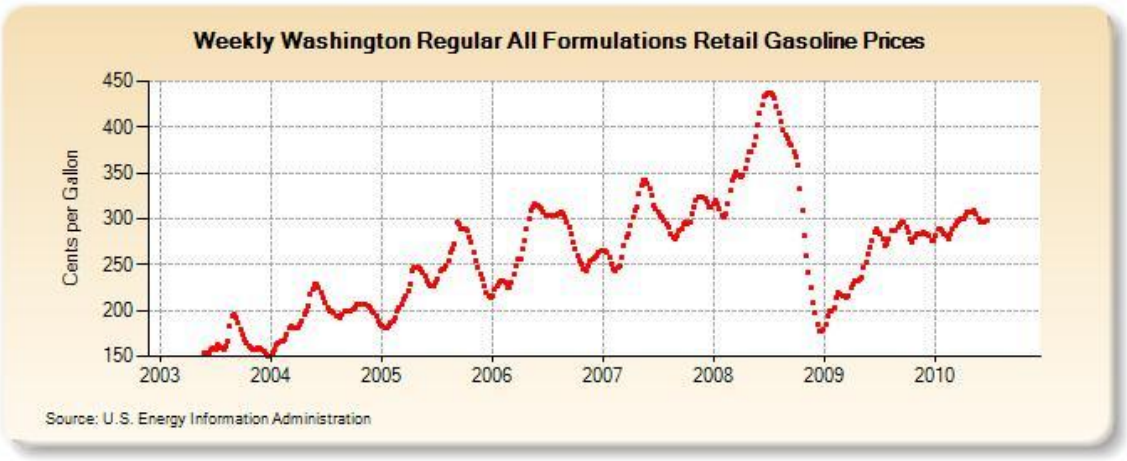
It's in the memory of the american the recent oscilantions of the price of oil and as a consequence the price of gas.

And considering that the price of electricity in the last 5 years increase in 62,5 % this means that peoples concern with energy is increasing but this doesn't mean that it's a lot.

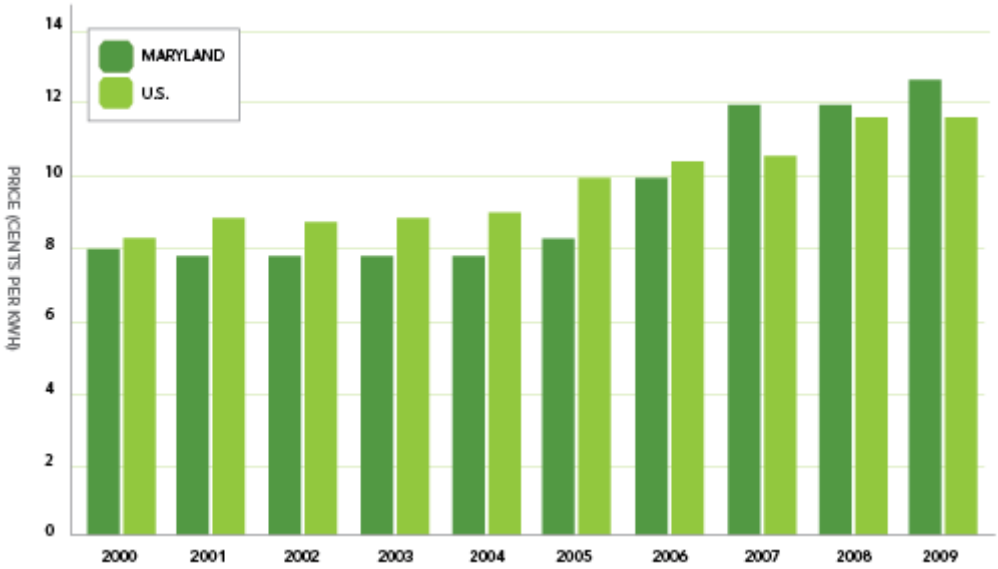
In the US the awareness is really low and this must be taken into consideration in the way the intervention is done.This mean that it will be needed a greater level of instructional intervention. Not only to create awareness but also to increase concern.



Picture 4. 1- Price of oil in the last 10 years [39]



Picture 4. 2- Gas prices in the last 7 years



Picture 4. 3- Evolution of the price of electricity over the years[40]

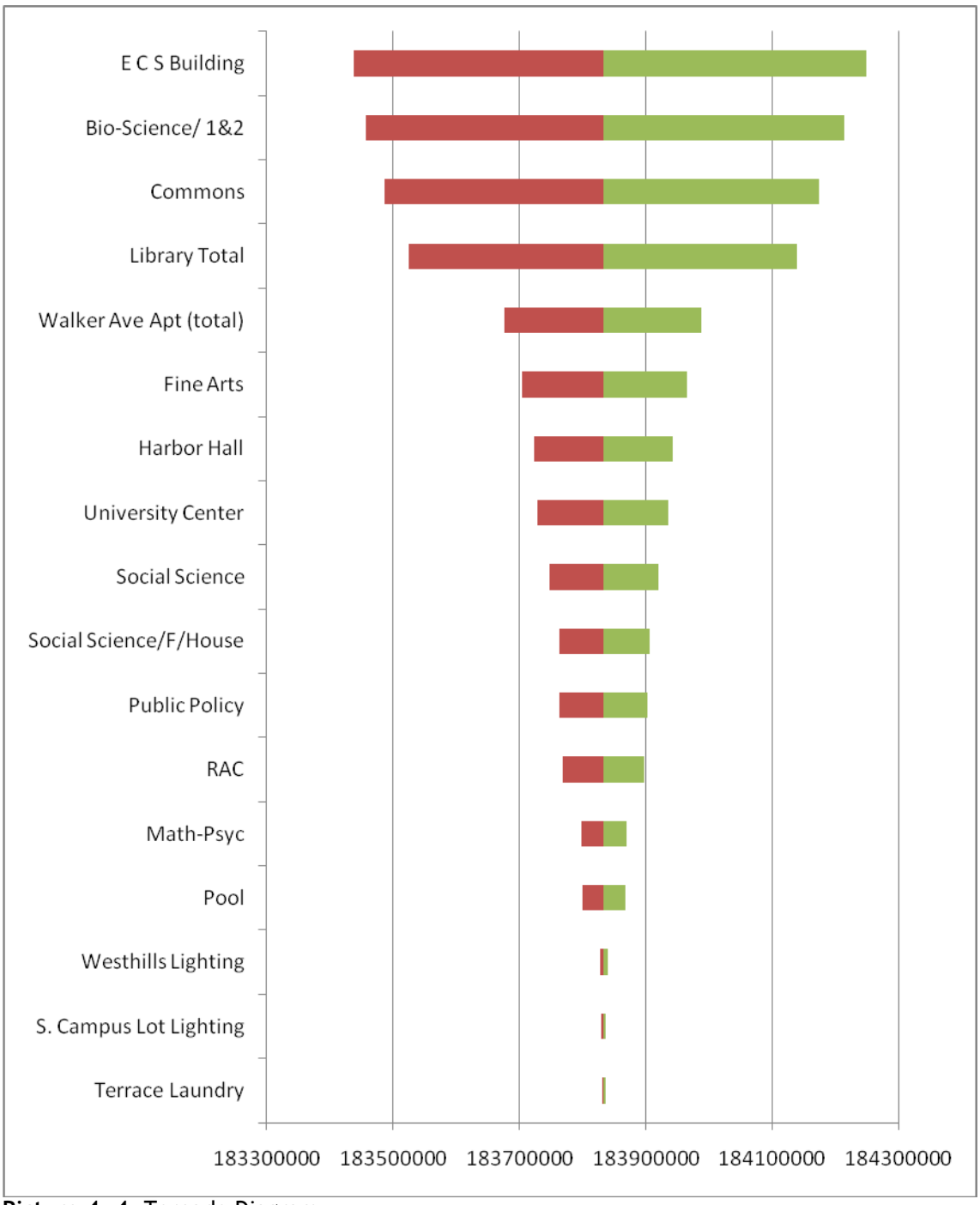
In order to define the study area we must first start by analyzing the consumption of electricity not only the average but also the influence of each building on the fluctuation of the total consumption:

	Consumption(KWh)		
Building/Location	Jan-10	Fev-10	Mar-10
Central Plant-2	8198	8198	8198
Physical Plant Shops	175,036	178	180
Chesapeake	5499	5498	5506
Hillside Water Heater	3641	3645	3649
Dining Halls	9120	9122	9133
Ac/Services-Theatre	1708	1699	1686
Satellite Plant	4392,6	4411	4427
Patapsco	6871	6912	6952
Hillside Laundry	3947	3990	4030

Social Science/Admin	2	28	89
Susquehanna	7293	7201	7209
Warehouse	1966	2024	2062
TRC 480 VOLT	44945	44962	45045
Hillside Store	7976	8035	8078
Patapsco	5809	5859	5918
Stadium	1625,376	1710	1771
Potomac	8061,28	8146	8237
TRC Building	5648	5797	5927
Erickson Hall	13680,7	13829	13976
TEC Building II	10024	10208	10385
ITE	17057	17248	17438
Susquehanna	2815	3044	3269
Chesapeake	3052	3294	3514
Physics	2445	2727	3033
Central Plant-1	257	606	1016
Terrace Water Heater	77361	77779	78149
Chemistry	3887,56	4287	4737
Westhills Water Heater	91522	92094	92707
Old Alumni House	27802	28615	29372
Terrace Office	92144	93478	94145
Hazard Waste TEC	13780	15602	16786
Child Care	80050	82417	84827
New Alumni House	76010	79040	81434
Terrace Laundry	90115	93190	95895
S. Campus Lot Lighting	55382,24	58432	61529,97
Westhills Lighting	86714	93211	98840
Walker Ave Apts 5B-B	1814212,9	1840381	1861666,8
Pool	2166692,3	2197918	2234205,3
Math-Psyc	1896743,6	1930800	1968478,3
Walker Ave Apts 5B-A	4555278,5	4622734	4679115
RAC	5924713	5989409	6054038
Public Policy	5381629	5451289	5520977
Walker Ave Apts 5A	6578549	6655801	6719553,5
Social Science/F/House	3504206,3	3572709	3647366
Social Science	8128988	8211490	8301157
University Center	4422154,5	4530901	4629054
Harbor Hall	12547420	12659402	12767949
Fine Arts	12273372	12400935	12533796
Walker Ave Apt (total)	12948040,4	13109097	13260335,3
Library Tower-PhaseIII	13658221	13810144	13970547
Commons	32909204	33262496	33597240
Bio-Science/ 1&2	8974914	9345946	9732191
E C S Building	29980268	30355020	30792084

Table 4. 1- **UMBC Building consumption**

Now after grouping buildings by their use we can see that Walker Ave Apartments have all the same kind of use as there is a partition on the Library Usage:



Picture 4. 4- Tornado Diagram

$$W_{\%} = \frac{W_i}{\sum W_j}$$

Average comsumption weight	
Bio-Science/ 1&2	5%
Harbor Hall	7%
Fine Arts	7%
Walker Ave Apt (total)	7%
Library Total	15%
Commons	18%
E C S Building	17%
Total (4+5+6+7)	55%

Table 4. 2- Consumption weight of total selected target for behavior change.

The chosen areas to be affected will be Walker Ave apartments, Library, commons and E C S Building.

4.2 - Types of behaviors

4.2.1 Curtailment behaviors

Instructional intervention

Considering the rising trend of electricity price and the fact we can change that this commodity is becoming more and more expensive. And yet awareness seems to escape the public so in order to decrease the consumption we will need to start by having an instructional intervention.

This intervention doesn't need to like really obvious because most of the times that is a waste of money and drives people away.

The instructional intervention in this case might be something more subtle like in the form of a survey with the questions keep asking questions and at the same time giving the answers that way people will start understanding that how wasteful they really are or that they weren't aware that in just 5 years the price of electricity just increased 62.5%.

Most of the people on the labs and at home they aren't aware of the efficiency of the machinery they have most of the time leave it at stand by and if we talk about building manager we can also talk about the cleaning crew.

The way cleaners mark the area of the building that wasn't still cleaned if by letting the lights on. This is done all over UMBC and is a terrible was of energy.

Raising awareness is essential to decrease the huge amount of energy that is being wasted on UMBC.

Motivational intervention

The motivational intervention will end up being trickier because people when faced with different kinds of incentives they tend to be motivated but as soon as the incentives end the motivation ends with them. So there could be a different kind of intervention both on a positive side where people would feel happy and challenged but also on the negative side.

By positive and negative I mean there would be needed multiple interventions:

Commitment

On the commitment there would be like a signing of a managerial contract where the building managers would be assuming a commitment to increase a more efficient use of energy.

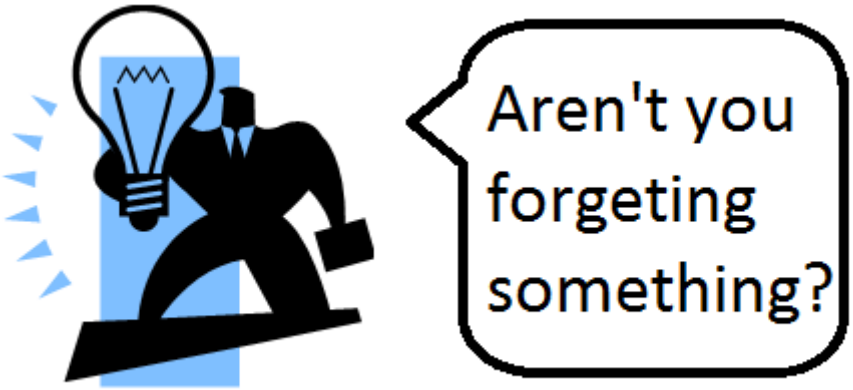
On the other hand people the everyday users of building s would be faced with different situations:

- *Housing:* Competition between housing units to see what would have a bigger drop on consumption and the prize would be that, that housing unit would have a discount on the energy bill on the amount of the other houses value.
- *Commons:* Motivational competitions exactly on the same kind of situation but between those companies located on the commons
- *ECS Building:* Pressure on lab responsible' to delegate good habits of usage of resources. Computer rooms don't need to be all open with all the computers on. Usage of those rooms should be accommodated to the need of people.

Prompts

There should everywhere in order for people not to do the little things, and will be the little things that will end up enabling the everyday users to remember of the big things

Like a turn of the light sign when you leave the laboratory that would not only make people remember to turn of the light but also to turn of the machinery if it's not being used.



Picture 4. 5- Prompt example

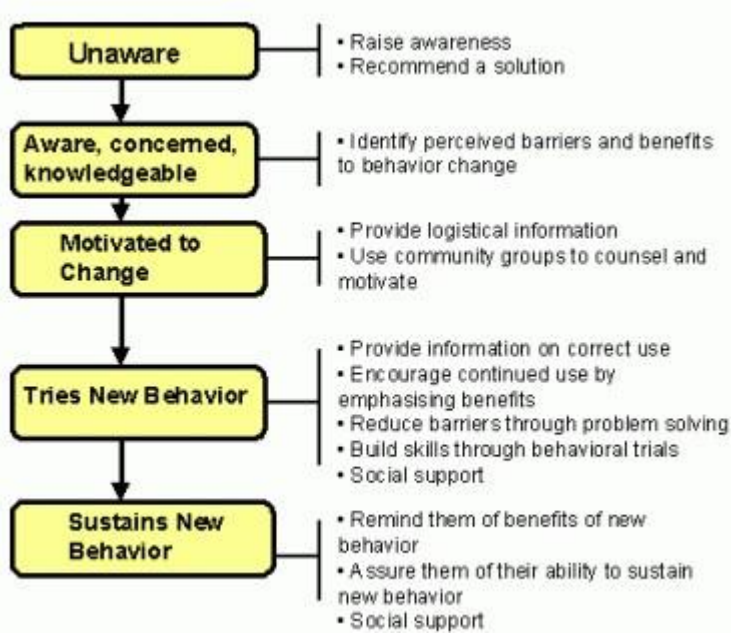
On the supportive intervention we shall make an interesting kind of intervention this might seem like something that doesn't have much to do with it but in the end it gets people thinking and in reality doesn't increase the cost.

The trick is to make a continuous information of how much money was saved by on the year by the total of people so that people will be able to see the "SCORE" of their challenge that way they will feel fulfilled and motivated.

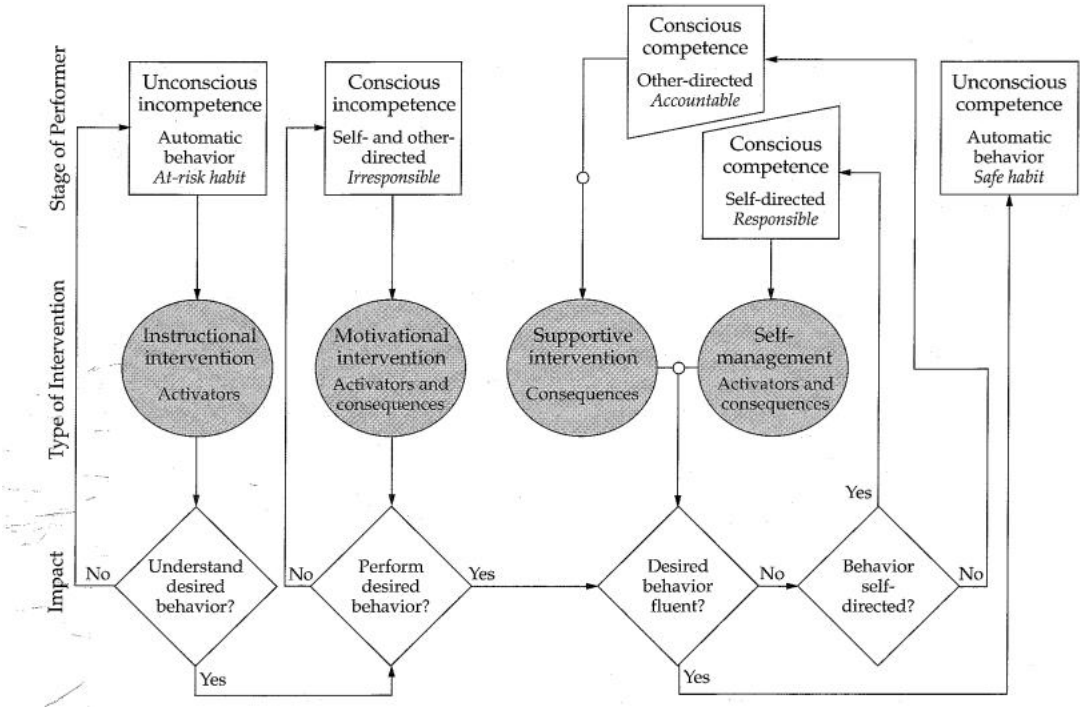
Picture 4. 6 Desktop widget that shows how much and who saved energy

Self-Management

The self-management will be the more important thing, since the intervention might be over but we need to see if the effects keep the people moving forward keep people being efficient this mean that the "SCORE" board doesn't need to be changed taken down when the intervention ends. The SCORE board should be kept in order to give feedback to people and to able people to see if their effort is paying off.



Picture 4. 7- Stages of awareness



Picture 4. 8- Advisable interventions with Geller [6]

4.2.2 One time efficient behaviors

The one time efficient behaviors will be dependent on the contracts signed by the building managers.

Keeping UMBC efficient could also be done by making many interventions:

Increasing the lighting efficiency

Not only by changing to better efficiency lamps once the previous lamps breakdown but make a reasonable usage map of the lighting on campus.

This means for example the library doesn't need to have all the floors lit (for security reasons) when there's nobody there. The first and second floors would suffice.

Increasing the fridge/oven/microwave efficiency

This would mainly affect the commons but there are other areas that would be affected if when changing fridge oven or microwave instead of buying the cheapest one the more efficient would be bought there would be a great drop of peak usage of energy.

Machinery efficiency

This might be the trickiest part because getting the machinery is already a challenging event now searching for a more efficient machine would be desirable but not actually something that is easily controllable.

On the other hand when talking about the computers there could always be studies to see what is more efficient and able to do the same work with the least energy. And which one has the least energy usage on standby.

Balancing the classroom usage

There should be created a central informatics usage program that would allow that the usage of classrooms all over campus would be optimized and in that way there wouldn't be need for the lights of all building be up all night just because there's one class on the building.

This central informatics usage program could also be able to correlate the thermostat temperature with the outside in order to create a comfortable temperature on the inside but at the same time not to be needed to huge amounts of energy to keep the temperature on the inside of the build on the exact opposite of the outside. Because this is not only wasteful but also uncomfortable on the long run.

4.3 - Structure of the Survey

Foot in the door technique

When an individual agrees to an initial small request, the likelihood that he or she will subsequently engage in a more substantial activity increases dramatically- the so called "Foot in the door effect". Commitment techniques have been used to foster a variety of activities that favor the environment ([41]). For example bus ridership has been increased using commitment ([42]), as has household energy efficiency ([43])

Principles:

1. Focus intervention on observable behavior
2. Look for external factors to improve performance

3. Focus on positive consequences to motivate desired behavior
    a. ABC contingency :
        i. A-> activator
        ii. B->behavior
        iii. C->consequence

The DO IT process:

The DO IT process is a general behavior analysis method for solving the behavioral dimension of environmental sustainability. It provides objective data for exploring why certain environment-destructive behavior. If an intervention does not produce a desired effect, it is either refined or replaced with a completely different behavior change approach.

"D" for define:

Behaviors:

		One time efficiency behavior	Curtailment behaviors
E C S Building	Management	Efficient lighting/machinery	Temperature regulation
	Consumers		Turn of machinery/lighting
Commons	Management	Efficient lighting/machinery	Temperature regulation
	Consumers	Efficient appliances	Turn of machinery/lighting
Library	Management	Efficient lighting/machinery	Temperature regulation
	Consumers		Turn of machinery/lighting
Walker Ave Apts	Management	Efficient lighting/machinery	Temperature regulation
	Consumers	Efficient appliances	Turn of machinery/lighting

Table 4. 3- Targeted behaviors

"O" for observe

E C S Building	Management	Show little to low concern with energy usage of the university
	Consumers	Unaware of the weight their usage has on final consumption. Cleaning ladies mark the place they are

		going to clean by leaving the lights on. Classroom usage chaotically distributed
Commons	Management	Show little to low concern with energy usage of the university
	Consumers	Unaware of the weight their usage has on final consumption. Cleaning ladies mark the place they are going to clean by leaving the lights on.
Library	Management	Show little to low concern with energy usage of the university
	Consumers	Unaware of the weight their usage has on final consumption. Cleaning ladies mark the place they are going to clean by leaving the lights on. Lights never turned of because of security reasons
Walker Ave Apts	Management	Show little to low concern with energy usage of the university
	Consumers	Unaware of the weight their usage has on final consumption. Little to no motivation to change bad habits.

Table 4. 4- Observed behaviors

"I" for intervene

Consequences of Environmental Protection-

Skinner([44]) claimed that behavior is determined by its consequences, and that we shouldn't expect many people to modify their behavior as a result of information or advice alone(i.e. activators) especially when information pertains a distant future.

E C S Building	**Management**	Monetary savings
	Consumers	Less pressure from superiors
Commons	**Management**	Monetary savings
	Consumers	Monetary savings
Library	**Management**	Monetary savings
	Consumers	Feeling of accomplishment and of a mission accomplished
Walker Ave Apts	**Management**	Monetary savings
	Consumers	Sense of accomplishment and challenge

Table 4. 5- Feelings after successful the intervention

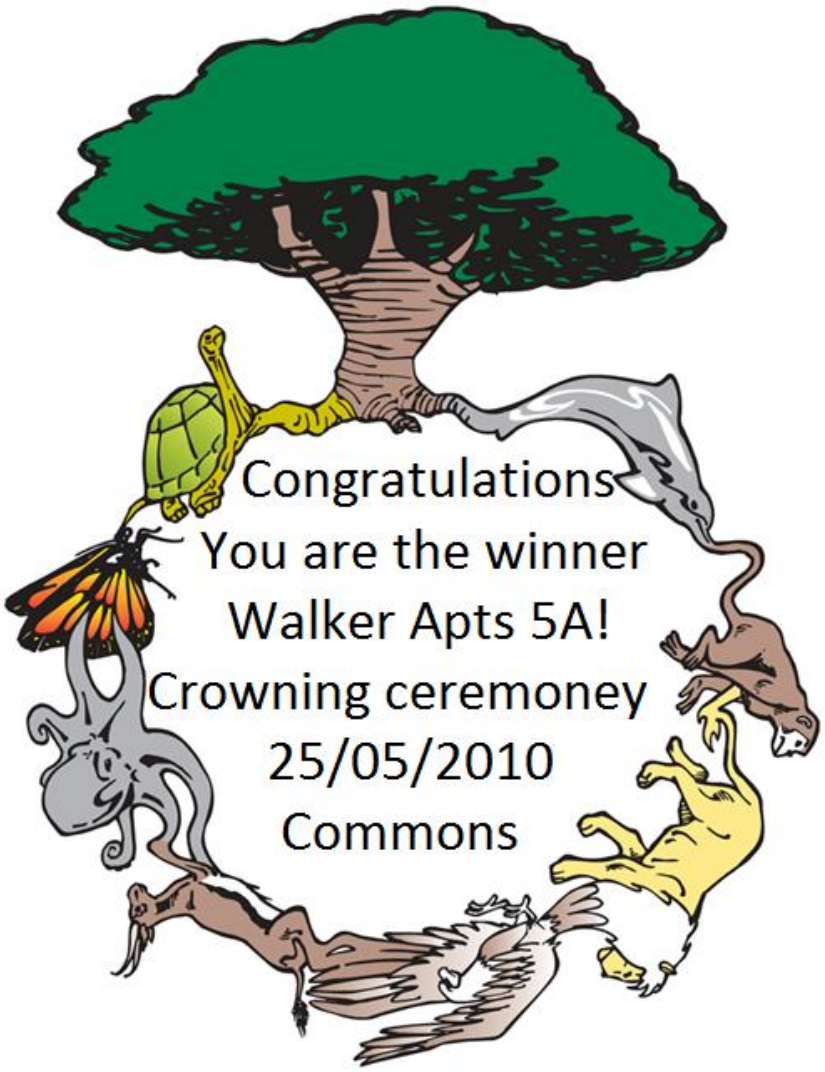
Rewards vs Penalties-

Incentives and disincentives are activators that announce the availability of rewarding or penalizing consequence.

		Rewards	Penalties
E C S Building	**Management**	Monetary savings	
	Consumers	Confort	Pressure from superiors
Commons	**Management**	Monetary savings	
	Consumers	Monetary savings,Confort	Pressure from superiors
Library	**Management**	Monetary savings	
	Consumers	Confort	Pressure from superiors
Walker Ave Apts	**Management**	Monetary savings	
	Consumers	Monetary savings, Prize competitions	Loser feeling

Table 4. 6- Rewards vs Penalties

Types of Rewards Contingencies-



Picture 4. 9- Prize awarding ceremony

The reward contingencies implemented for environmental sustainability have been diverse. Some rewards have been given after the performance of a desired target behavior, whereas other rewards have been contingent upon a particular outcome.

Feedback Techniques-

Most of the feedback research for environmental protection addressed residential energy consumption and the feedback was usually given to residents (e.g. reviews by Shippee[8]; Winett[9]).

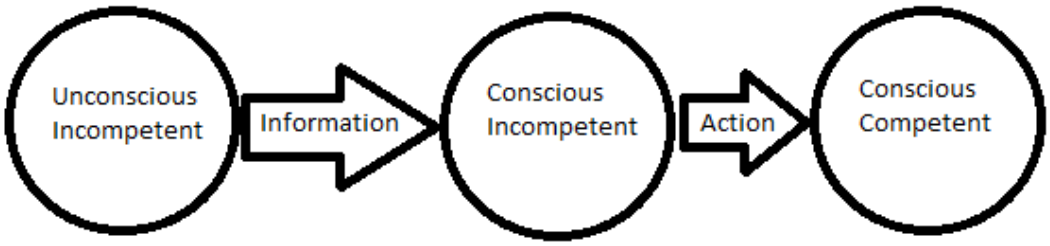
Picture 4. 10- Motivational prompt

Picture 4. 11- Motivational prompt

<u>"T" for test</u>

The test phase of the DO IT process provides behavior change agents with the information they need to refine or replace a behavior change intervention. If behavioral observations during this phase indicate lack of significant improvement in target behavior, the behavior change agents analyze and discuss the situation, and then refine the intervention or chose another intervention approach.

Three Stages of behavior



Picture 4. 12- Three stages of behavior

4.4 - Three Basic Intervention Approaches:

The activators and consequences of the ABC contingency described earlier in principle are external to the performer, or they are internal (as in self-instructions or self-recognition). They can be intrinsic or extrinsic to a task, meaning they provide direction or motivation naturally as a behavior is performed, or they are added to the situation extrinsically in order to improve performance. An incentive/reward program is external and extrinsic. It adds an activator and a consequence to the situation in order to direct and motivate desirable behavior.([10]).

As with Functional Analysis, descriptive functional behavior assessment utilizes direct observation of behavior; unlike functional analysis, however, observations are made under naturally occurring conditions. Therefore, descriptive assessments involve observation of the problem behavior in relation to events that are not arranged in a systematic manner.

There are three variations of descriptive assessment:

- ABC (antecedent-behavior-consequence) continuous recording - observer records occurrences of targeted behavior and selected environmental events in the natural routine.
- ABC narrative recording - data are collected only when behaviors of interest are observes, and the recording encompasses any events that immediately precede and follow the target behavior.
- Scatterplots -a procedure for recording the extent to which a target behavior occurs more often at particular times than others.

The one that was chosen in this method consist of ABC narrative recording. In this method not only the feedback from frequent surveys is used but actually it ended up being a mix between the narrative recoding and the continuous recording since thanks to certain

technologies that are in case like continuous feedback from the computers and the permanent scoreboard.

In the end, the method is not defined in this part because depending on the situations and even the groups there could be a great deal of variation in the intervention approach.

Chapter 5 - Feedback analysis

5.1 – Survey development

The survey was done dividing 2 main target people:

- Building management
- Building users

Those main areas were sub divided into:

- E C S Building
- Commons
- Library
- Walker Ave Apts

In this survey, I used internet site called survey monkey. There the target audience had each of them a specific survey.

The surveys had certain questions that were common to all and certain questions that would target the specificities of each building or target people.

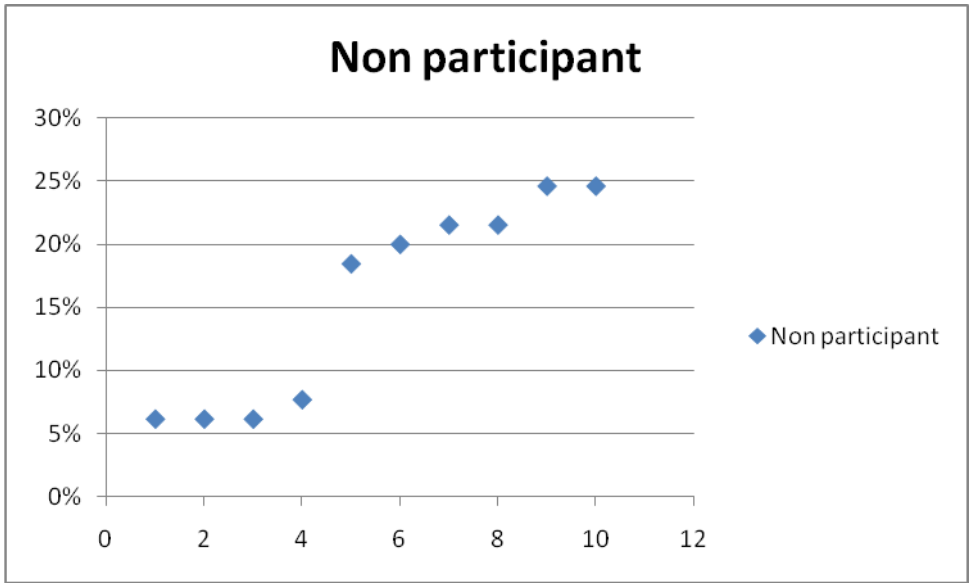
The survey questions and specific links are placed on appendix 2.

On appendix 3 we have the results of the surveys.

We can see various things by analyzing the results of the survey.

I need to start by pointing out that some of the questions even considering that they are important they actually there in order to gradually elevate the level of requests. This is in fact the main part that the foot in the door technique consists on.

I could even say that the foot in the door technique was poorly calibrated. We can see that especially in most of the surveys done to the consumers. After 5 questions the receptivity for the surveys seems to drop sharply. This means that the evolution of the questions was either too slow or too fast. But since this is a 10 question survey we can easily deduce that the evolution was too slow.

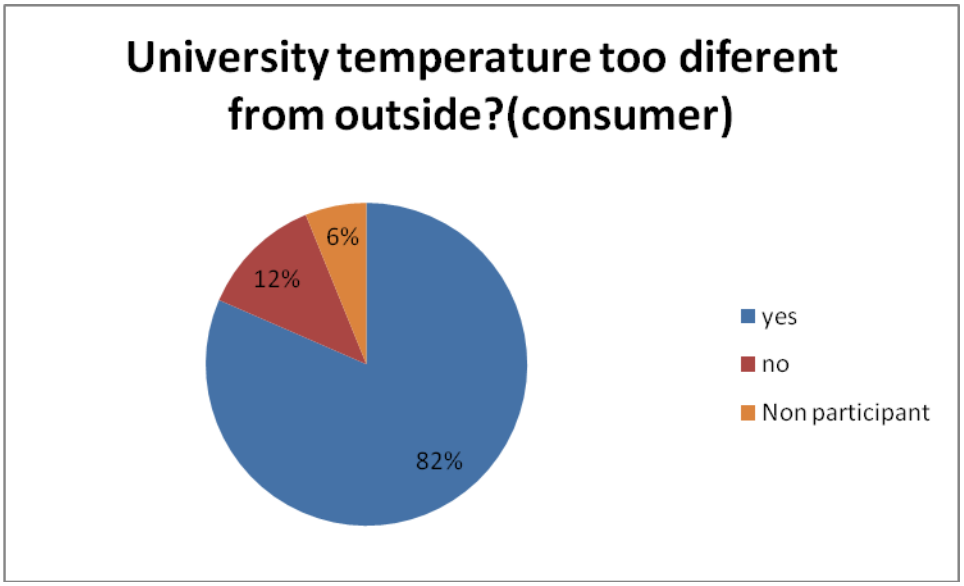


Picture 5. 1- Example of evolution of Non participation

It was taken into consideration the fact that the total population of the management of all the buildings consists of only 14 people. But, the fact that, their decisions weight so much ends up being important enough to separate from the rest. And, considering that what they do influences in a different way this means that the intervention should be different on each.

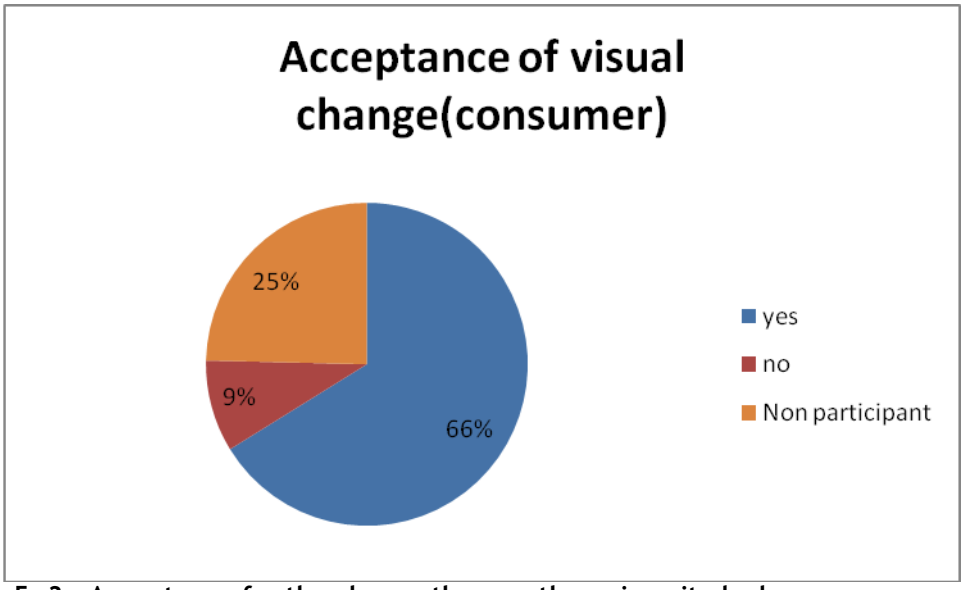
Thanks to the survey data I was able to determine the behavior concern, behavior intention and the actual behavior action.

Even if it wasn't obvious, also, I integrated in the survey an area where I checked the level of acceptance for certain interventions where I was able to see that with the exception of Walker Ave atps. there was a high level of acceptance to the decrease of the temperature difference with the outside temperature.

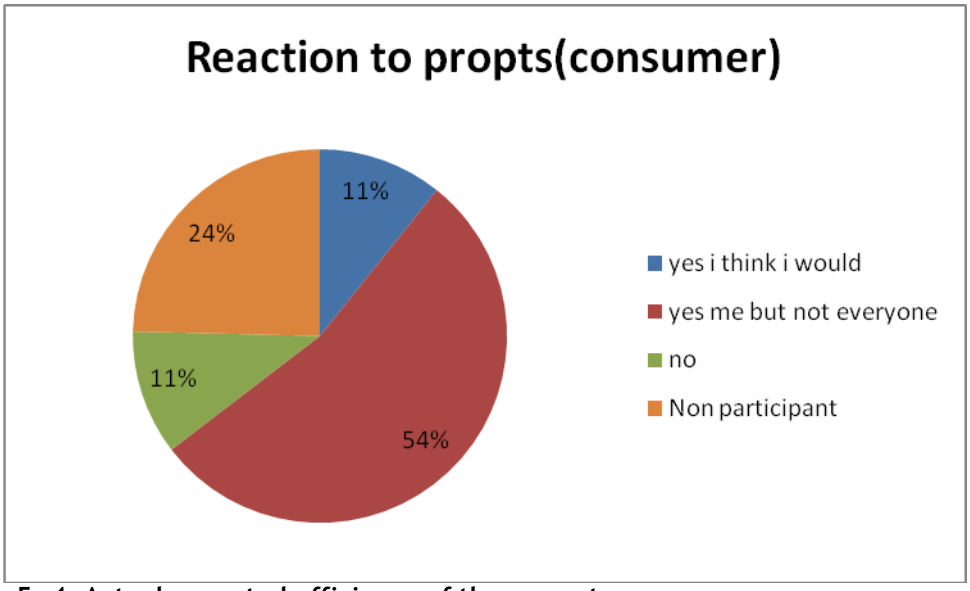


Picture 5. 2- Aceptance for lowering the temperature difference witht the outside

But if we think about the reaction to the prompts taken in consideration of the fact of where it was on the survey:



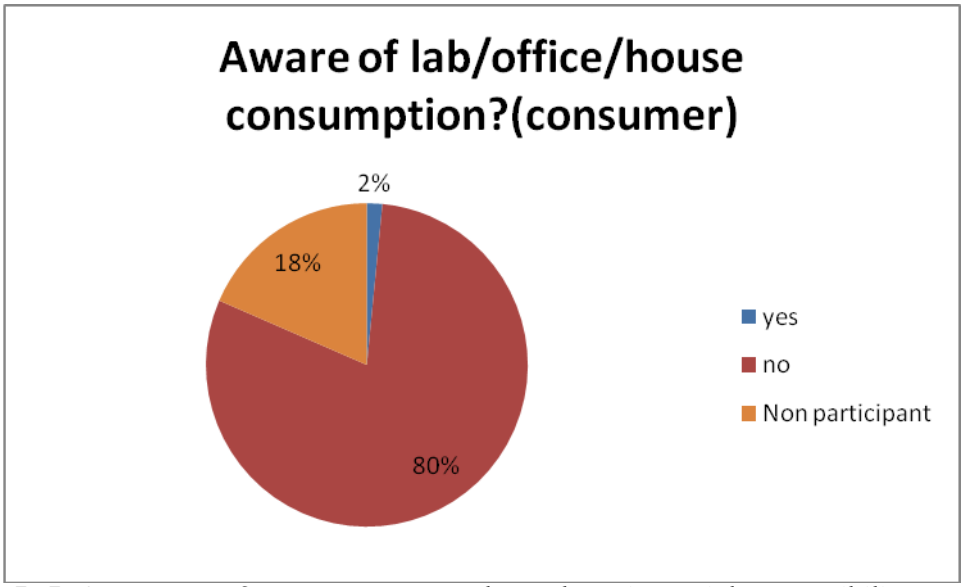
Picture 5. 3 - Acceptance for the change the way the university looks



Picture 5. 4- Actual expected efficiency of the prompts

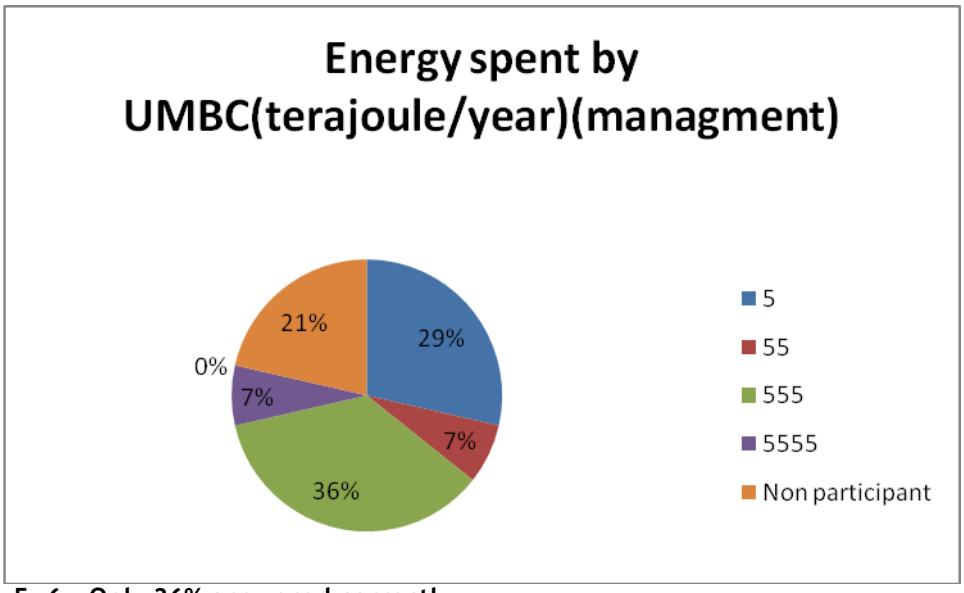
The result are pretty convincing, because even if, people don't believe that the not everyone would be reminded by the prompts it ends up being funny because only 11% admit that they wouldn't be affected by the prompts.

Important information, from the survey, is the fact that an informational campaign is needed because not only the consumers are completely oblivious of the consumption they do:

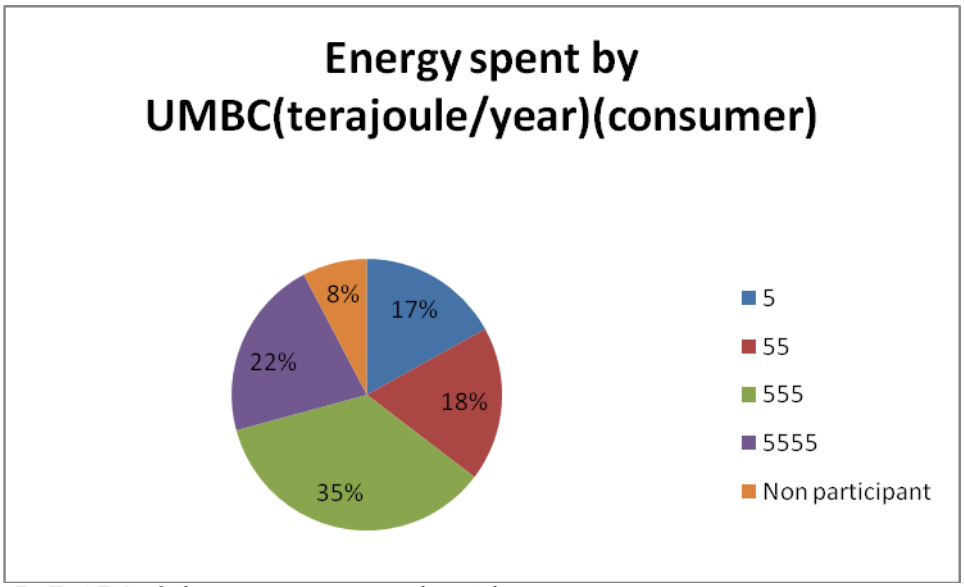


Picture 5. 5- Awareness of energy spent on where there is partial responsibility

Not only the general population doesn't know how much energy is spent on one year by UMBC but also the management is unaware.

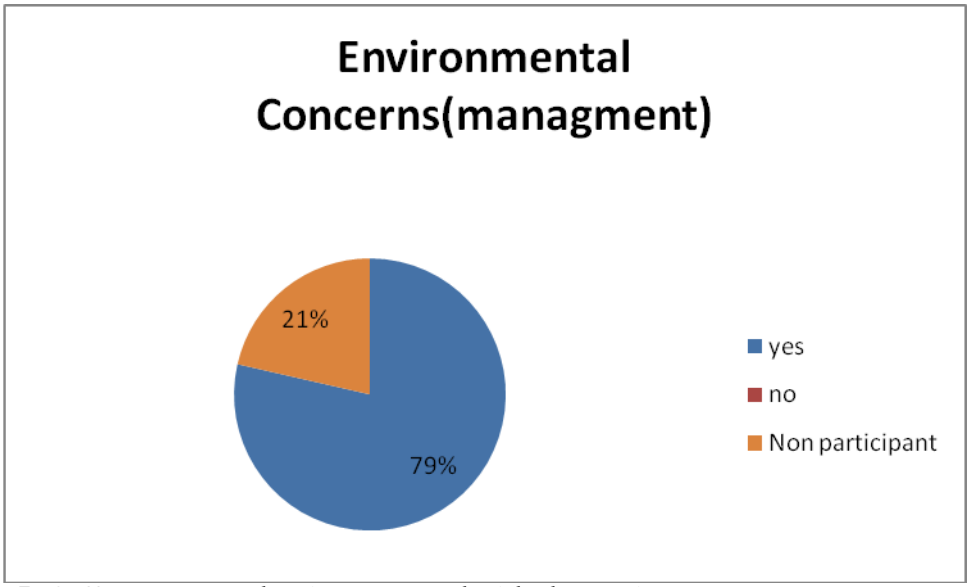


Picture 5. 6- Only 36% answered correctly



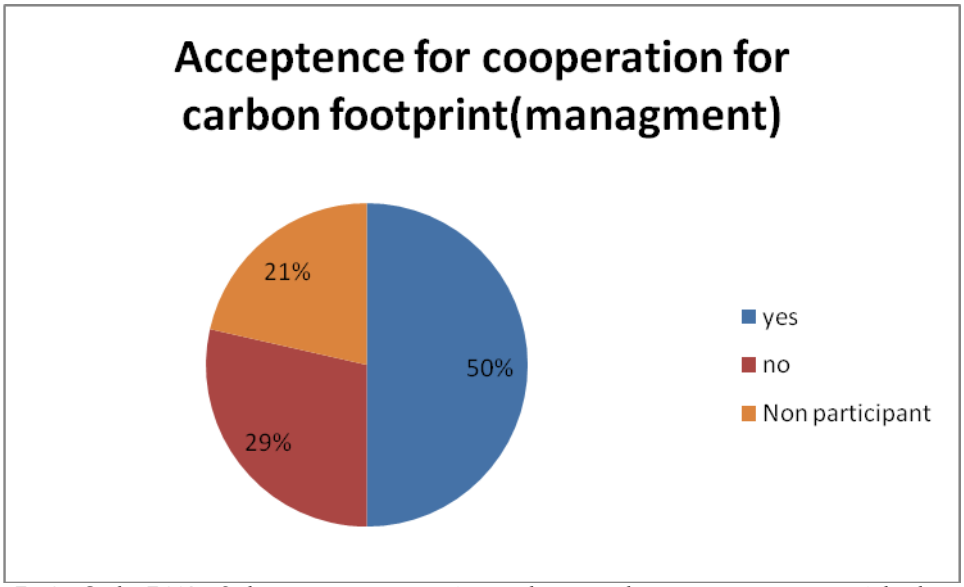
Picture 5. 7- 35% of the consumers got the right answer

The lack of difference between the management and general population means that even if the management showed a great deal of environmental concern that didn't actually meant action or real practical concern:



Picture 5. 8- Management that is concerned with the environment

But the problem is that the concern isn't mirrored in predisposition to act in a way that would decrease the energy consumption:



Picture 5. 9- Only 50% of the management intends to make an agreement with the other building managers the others don't care or don't want

Now if we follow Kaiser's model we will be able to define the predictive influence of the intervention. First we need to separate the individual behaviors.

The probability for the management should be 57% and 62% this is a result of the difference between a person's commitment and the realization costs. The calculations are explained in the appendix 1, but the calculation data is on appendix 3.

$$p(x_{ki} = 1|\theta_k,\delta_i) = \frac{\exp(\theta_k - \delta_i)}{1 + \exp(\theta_k - \delta_i)}$$

$P(x_{ki}=1|\ 0.79, 0.5)=57\%$

$P(x_{ki}=2|\ 0.72, 0.47)=62\%$

Chapter 6 – Conclusions and Future works

In this work, I've started by showing that there is a great need in increasing efficiency in which energy is spent. Presently most energy is mostly spent either in a wasteful way or simply is wasted just because the machinery that is used in order to achieve a certain result has low efficiency.

Up until now electrotecnic engineers have focused their work when energy efficiency is concerned in increasing the energetic efficiency of the machinery that is used but the human part of the situation has been forgotten.

So, I give a vision on the contributions that the main scientists have been giving in that matter. But it has been mainly done by psychologists so some details have been forgotten, or simply, not applied just because there wasn't interest in that.

After an introduction to Geller theory, Kaiser Theory and McKenzie-Mohr theory, I give a vision of how it is possible to interconnect those theories and at the same time apply them directly to a situation of behavior change towards a more energy efficient university.

Finally, thanks to a survey I've done I was able to get the feedback where I could see where my intervention was wrong, I was able to predict the probability of actual incidence to the behaviors and finally I was able tweak my method in order to provide a more complete and correct method.

So I think that it would be interesting to develop this work by deepening the engineering factor of this work. The method developed can be considered quite mechanical so it could be applied in various situations. A program could be done where all situations and behaviors could be defined for a certain number of buildings and people, in this way, the result of this work could be considered a new tool.

Appendix 1

Geller Theory

In the “Handbook of Environmental Psychology” Geller admitted while many utility companies push conservation they don’t apply the most effective behavior change techniques defined by research. Likewise, water suppliers and municipalities periodically ask residents to avoid certain water wasting behavior; but such requests are usually reactive (i.e. when water shortage is imminent) rather than proactive, and it seems strategic applications of behavior analysis techniques are rare except for education, prompting, and policy enforcement. It’s encouraging that most major appliances are sold with an “energy Guide” but the impact of these “activators” could be significantly enhanced if behavior analysis and self management principles had been considered when they were designed.

Lack of environmental impact

There are many possible reasons for the failure of these behavioral community studies to cause a visible impact on environmental preservation. One of the most obvious things is the limited audience of these demonstration projects. Most of the cases the research is published in professional journals and books read almost exclusively by other psychologists. Even considering the convincing demonstrations of the efficacy of their behavior change techniques they are given to people that have little interest or even influence in a possible large-scale dissemination and application. In other words, the critical social marketing aspects of behavior change technology have not been addressed [6].

Bailey comments on this dissemination problem:”We have a great science (the experimental analysis of behavior) and a pretty good technology (applied behavior analysis) but no product development or marketing”[7] and have “neglected to develop socially acceptable terminology for presenting our concepts to consumers… we have, in our zest for science and technology, taken the human concerns out behavior analysis”. [7]

There might be another problem in the selection of which behaviors to change. Oskamp and Haward stated overconsumption as the key threats to environmental sustainability, denying litter control nor recycling, which have been so far the targets of most concern shown

by behavior analysts[45]. Gardner and Sterndistinguish defined both the curtailment behaviors (like reducing consumption) and the efficiency behaviors (that consist of the decrease of resource consumption made by equipment and machinery).By emphasizing that people can make more energetically efficient water heaters and vehicles than by carpooling or insulating their current water heater. It's also added that, efficiency behaviors need a single time investment on more environmentally friendly commodities (from vehicles and major appliances to home heating and cooling systems), on the other hand curtailment behaviors usually involve the repetition of an inconvenient or sacrificial action (from collecting recyclables and carpooling to turning back thermostats and reducing water use). There has been a trend for behavior analysts to target curtailment behaviors instead of one-shot efficiency behaviors.[46]

Regarding the design of behavior change interventions, Boyce and Geller were able to reach the following conclusion from their comparison of behavior-based interventions that resulted in substantial versus minimal behavioral maintenance:

- Reward schedules that are just sufficient to initiate behavior change are more likely to produce longer-term behavior change than more powerful rewards.
- Global or general representations of desirable behavior results in more behavioral maintenance than references to specific behavior.
- Behavioral commitment strategies accompanied by information regarding the rationale for performing a target behavior can have a long term effect.

Principles:

4. Focus intervention on observable behavior
5. Look for external factors to improve performance
6. Focus on positive consequences to motivate desired behavior
    a. ABC contingency :
        i. A-> activator
        ii. B->behavior
        iii. C->consequence

The DO IT process:

The DO IT process is a general behavior analysis method for solving the behavioral dimension of environmental sustainability. It provides objective data for exploring why certain environment-destructive behavior. If an intervention does not produce a desired effect, it is either refined or replaced with a completely different behavior change approach.

"D" for define:

Behaviors:

>environment protective/destructive

>One time efficiency behavior/curtailment behaviors

"O" for observe

This stage the objective isn't to find faults but to find the facts, this process ends up facilitating the discovery of best behaviors and conditions that need to be changed or continued in order to protect the environment

"I" for intervene

In this stage interventions are designed and implemented in order to increase pro-environment behaviors or decrease environment-destructive behavior.

Consequences of Environmental Protection-Skinner(1987) claimed that behavior is determined by its consequences, and that we shouldn't expect many people to modify their behavior as a result of information or advice alone(i.e. activators) especially when information pertains a distant future.

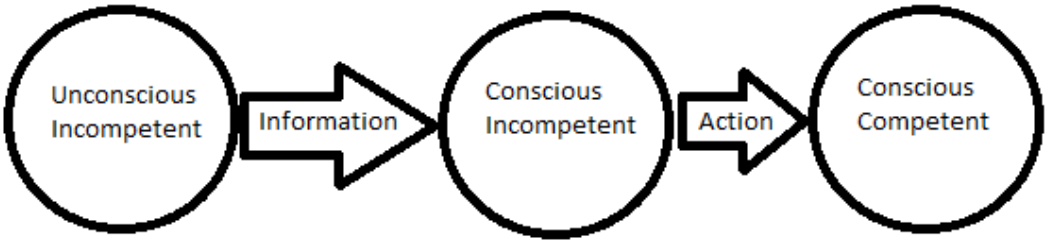
Rewards vs Penalties-Incentives and disincentives are activators that announce the availability of rewarding or penalizing consequence.

Types of Rewards Contingencies-The reward contingencies implemented for environmental sustainability have been diverse. Some rewards have been given after the performance of a desired target behavior, whereas other rewards have been contingent upon a particular outcome.

Feedback Techniques-Most of the feedback research for environmental protection addressed residential energy consumption and the feedback was usually given to residents (e.g. reviews by Shippee [8]; Winett [9]).

"T" for test

In the test phase of the DO IT process, information needed to refine or replace a behavior is provided. If in the behavioral observations, during this phase indicate a lack of significant improvement in target behavior, the behavior change agents analyze and discuss the situation, and then refine the intervention or chose another intervention approach.



Picture 1 – The three Stages of behavior

Three Basic Intervention Approaches:

Both the activators and the consequences of the ABC contingency as previously described are in principle external to the performer, or internal (as in self-instructions or self-recognition). A task's activators and consequences can be intrinsic or extrinsic, which means that direction or motivation is provided naturally as a behavior is performed, or it's added to the situation extrinsically in order to improve performance. A program with incentives and/or rewards is external and extrinsic. In order to direct and motivate a desirable behavior an activator and a consequence are added to the situation. [10]

Instructional Intervention

Instructional intervention consists of a planned set of procedures that are aimed at teaching a specific set of academic or social skills. An intervention ends up being more than a single lesson and less than an entire curriculum. The base characteristics of an intervention would be:

7. It is *planned.* Planning implies a decision-making process. Decisions require information (data) therefore; an instructional intervention is a data-based set of teaching procedures.
8. It is *sustained.* This means that an intervention likely is implemented in a series of lessons over time.
9. It *targets*, or is *focused* on, a particular student or students and on a particular set of skills or knowledge. This means an intervention is intended to meet a specific set of needs for a student(s).
10. It is goal *oriented.* This means that the intervention is intended to produce a change in knowledge/behavior (academic or social) from some beginning or baseline state toward some more desirable goal state.
11. It is typically a *set* of procedures rather than a single instructional component/strategy. Interventions typically address a range of ICEL considerations. For example: Instruction (e.g., pace, guided practice); Curriculum (e.g., correct level of difficulty, sequence); Educational Environment (e.g., allocation of instructional time or arrangement of instructional setting); and Learner (e.g., motivation patterns or prior knowledge of task).
12. Re-administering performance probes for progress monitoring is *NOT* an intervention.

Intervention Target(s)	Reason for intervention
• What will you teach? State Objective • What kind of information is it • Are all components of an objective stated? • Is an aim date specified? • Is “Fair pair” rule followed?	• Have a rationale for each intervention or component. • Alignment • Previous assessment data • Current specific-level assessment data
Specific Intervention Activities	Evaluation Procedures
• Materials • Time allocated • Instructional method • Compatibility with high-impact variable(e.g., ecology) • Performance monitoring procedures.	• How will you know if your instruction is effective? • What data rules will be applied?

Table 1 - Instructional intervention

Supportive Intervention

In order to turn the right way to do something into a natural routine, practice is important. The repetition of an action leads to fluency and, frequently, to automatic or habitual behavior. This is a state that is really useful in repetitive actions like the curtailment behaviors that need to be determined, but practice can benefit greatly from supportive intervention even if it does not come easily. Support and reassurance is needed in order for us to know that we are doing the right thing and to encourage us to keep going.

While instructional intervention consists primarily of activators, supportive intervention focuses on the application of positive consequences. Thus, when we give people rewarding feedback or recognition for particular behavior, we are showing our appreciation for their efforts and increasing the likelihood they will perform the behavior again. Each occurrence of the desired behavior facilitates fluency and helps build a good habit [11].

Motivational Intervention

Usually motivational intervention is required when people know what to do but do not do it. This means that they require some external encouragement or pressure to change. Instruction alone is obviously not enough because they are consciously doing the wrong thing. Geller refers to this as a “Calculated risk”. [11]

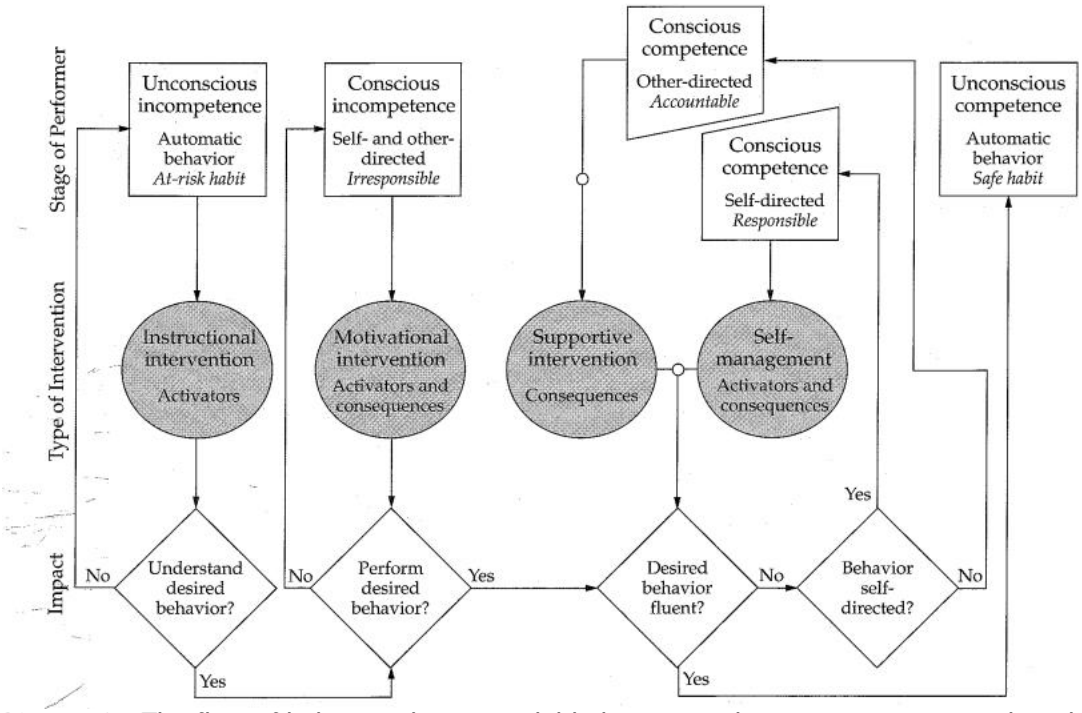
Usually, when we usually perform calculated risks it’s because we see the positive outcome of the at-risk behavior to be of greater value than the negative consequences. This happens because the positive outcome like comfort, convenience, and efficiency are immediate and certain, while the negative consequence of at- risk behavior (such as Green house effect, raise of the price of oil) is a possibility and seems remote. Also there’s the fact that the safe alternative is relatively inconvenient, uncomfortable, or inefficient, and these negative consequences are immediate and certain.

This ends up being when an incentive-reward program is useful. Such a program attempts to motivate a certain target behavior by promising people a positive outcome if they perform it. The promise is the incentive and the consequence is the reward.

Rewards versus Penalties

Usually, governments use disincentives and penalties to promote environment-preserving behaviors. They in order to protect the environment frequently use ordinances or laws (e.g., fines for littering, illegal dumping, or using excessive water or for polluting land, water, or air); and to be effective, these disincentive/penalty interventions usually require extensive promotion (activators) and enforcement (consequences). This approach has been de-emphasized mostly because negative effect, feelings, or attitudes typically accompany attempts to mandate behavior change through disincentive/penalty tactics.

When we link a positive attitude with a change in behavior, odds are that the desired behavior will end up being a social norm. Positive attitudes are more likely to follow an incentive/reward approach than a disincentive /penalty intervention because the former approach is more likely to be perceived as "voluntary" and no threat to individual freedom[12].In fact, perceiving a threat to one's freedom can lead to behavior contrary to compliance with a mandate[13].



Picture 2 - The flow of behavior change model helps to match intervention approach with needs of the target individual(s)

Kaiser Theory

Kaisers' paper establishes environmental attitude as a powerful predictor of ecological behavior. Where past studies have failed in this enterprise because they did not consider three shortcomings that limit the predictive power of environmental attitude concepts:

4) the lack of a unified concept of attitude

5) the lack of measurement correspondence between attitude and behavior on a general level

6) the lack of consideration of behavior constraints beyond people's control

Based on Ajzen's theory of planned behavior, the Kaiser's study uses a unified concept of attitude and a probabilistic measurement approach to overcome these shortcomings. Kaiser confirmed three measures as orthogonal dimensions by means of factor analysis: environmental knowledge, environmental values, and ecological behavior intention. One other measure, general ecological behavior, is established as a Rasch-scale that assesses behavior by considering the tendency to behave ecologically and the difficulties in carrying out the behaviors, which depend on influences beyond people's actual behavior control. A structural equation model was used to confirm the proposed model: environmental knowledge and environmental values explained 40 % of the variance of ecological behavior intension which, in turn, predicted 75 % of the variance of general ecological behavior.

The key to such a system is a measurement instrument in which environmental motivation becomes tangible in individual actions. In this article, we provide empirical examples of such a decision support system in the environmental domain. It consists of (a) evidence about environmental motivation of persons, (b) evidence about motivation's spatial distribution, (c) knowledge about the socio-cultural conditions that affect individuals when they translate motivation into action (i.e. structural information), and (d) a forecast of the environmental impact—the concrete conservation potential of various behaviors.

Introduction

In most modern societies saving energy and decreasing consumption have become pressing matters. In order to help environmental policy-makers, psychology must prove itself in a way that it effectively helps decisions without providing useless information. The decision support system is based on quantitative empirical evidence and not in intuitions.

Nowadays psychology hopes to develop a way to decrease the exploration of earth's natural resources as a result of the environmental problems of the decrease of natural resources. [14];[15]

Kaiser defends that theoretical knowledge may eventually guide a campaign, but only after policy-makers have decided to adopt a motivation promotion strategy. He defends that most of policy-making involves decisions about rather basic issues. And hopes, to leave the

specifics of a campaign, be it a legislative, a monetary, or an educational one, to the promotion experts.

Since psychologists usually refer to individual behavior rather than to behavior of whole societies they ask questions such as what determines an individual's (ecological behavior i.e.) actions that work towards environmental preservation and/or conservation' [16] or how can behavior be changed in a more ecological direction. In answering these questions, environmental attitude is considered one of the most promising concepts [17]. In fact, almost two-thirds of all environmental psychological publications include environmental attitude in one way or another.

Environmental attitude and ecological behavior have a well-explored relationship.

Kaiser establishes environmental attitude as a powerful predictor of ecological behavior. Up until his study most failed to establish the relationship because they did not consider three shortcomings that limit the predictive power of environmental attitude concepts:

1) the lack of a unified concept of attitude
2) the lack of measurement correspondence between attitude and behavior on a general level
3) the lack of consideration of behavior constraints beyond people's control

Based on Ajzen's theory of planned behavior, Kaiser's study uses a unified concept of attitude and a probabilistic measurement approach to overcome these shortcomings. Data collected from members of two different Swiss transportation associations are used. Kaiser ended up confirming three measures as orthogonal dimensions by means of factor analysis:

4) environmental knowledge
5) environmental values
6) ecological behavior intention

One other measure presented was general ecological behavior, it was established as a Rasch-scale that determines the behavior by considering the susceptibility to act ecologically and the hardships behaving in the desired way, depending on influences that transcend people's actual behavior control. As a way to confirm the proposed model a structural equation was used: 40 % of the variance of ecological behavior intension was explained by environmental knowledge and environmental values which, in turn, predicted 75 % of the variance of general ecological behavior.

However, the relationship appears to be at best moderate across different studies [47]. This lack of a stronger correlation occasionally results in rather pessimistic views of the usefulness of environmental attitude as a predictor of ecological behavior [48]; [49].

Kaiser's paper proposes three reasons, that affect the predictive power of environmental attitude concepts, one theoretical and two methodological. Considering a theoretical point of

view, there are at least three main different attitude concepts. This difference complicates the comparison of research results in the ecological domain. Any attitude-behavior relationship is also affected by the two methodological flaws that affect the environmental attitude and ecological behavior relationship. Being those the lack of measurement correspondence and the lack of consideration of situational influences on a given behavior. Measurement correspondence refers to measurement of attitude and behavior on the same level of specificity [19]. The level of specificity should be rather general as a result of the multitude of situational influences. Situational influences refer to constraints and facilities on behavior beyond people's control Ajzen & Madden[24]. Inclusions of such behavior influences are seen as particularly important in the ecological domain [47];[50]; [51]; [52]; [53]; [54]. These influences are usually considered either as moderator effects or as a direct influence on the relationship between environmental attitude and ecological behavior. In both cases a rather arbitrary selection of possible influences is needed.

In his paper Kaiser promoted the theory of planned behavior [3] as an overall theoretical framework in the ecological domain. Also, in order to overcome the two methodological shortcomings a probabilistic measurement approach for the assessment of ecological behavior was used.

Three environmental attitude approaches and ecological behavior

The two types of environmental attitude used to predict ecological behavior are:

- attitudes toward the environment
- attitudes toward ecological behavior [47]

Olsen[55] also considers that the same is also possible in energy conservation. As the objective can be to change the attitude towards the natural environment, some of its characteristics (e.g. air quality) or the target attitude is ecological behavior (e.g. recycling or political activism). We can see environmental attitude towards ecological behavior in the work done by Fishbein and Ajzen. According to Hines [47] approximately one in each five studies that associate environmental attitude with ecological behavior mention the structure of the theory of reasoned action [22] and its more complete version, the theory of planned behavior [3]. On the other hand, behavior towards the environment frequently requires to environmental concern [56]. Environmental concern can be used a multiple component approach or as a single component approach [57] and includes the environment in general or some particular aspects of environment.

Considering that the attitude towards environment requires a multiple component approach, it will be used the distinction between cognitive affective and intentional components of attitude proposed by Rosenberg & Hovland[58]. We can trace back this research tradition to two studies by Maloney and colleagues [59]; [60]. An affect scale(AFS) measures the affective component, factual knowledge about the environmental measures the

cognitive aspects, and verbal commitment measures the behavior intention component of environmental attitude [61]. A fourth scale measures ecological behavior.

The Affect Scale (AFS) is an instrument developed to facilitate and systematize the assessment of an individual's affective functioning. The scale is specially designed for detecting affective disturbances. These are disturbances traditionally viewed as manifesting themselves in the form of depression or mania or both. The scale is also suitable for assessing the affective balance found in psychic disturbances of other types[62].

Originally, all three environmental attitude components: affect, knowledge (i.e. cognition) and intention were used in parallel to predict ecological behavior. Recent versions of this approach vary: some propose the affect component as the single indicator of environmental attitude [63]; [17], others abandon ecological behavior intention [64], while a third group uses the ecological behavior intention component as the single indicator of environmental attitude [65];[66];[67].

Rather than paralleling these environmental attitude components, in a way to predict environmental attitude or ecological behavior [68];[69];[70],some approaches use the concepts knowledge, affect and intention in a more consecutive way.

As it was previously said if we consider the attitude towards the environment as a single component approach, this attitude can be anticipated by knowledge, affect and intention. At times, environmental attitude is measured by knowledge, affect and intention items [71]; [72]; [16]. The new environmental paradigm (NEP), which is the third and most recently developed tradition of environmental attitude research [73];[74];[75], is an alternative, single component measure of environmental attitude. Many challenge its unidimensionality and use it alternatively as a multiple component measure composed of dimensions such as balance of nature, limits of growth and humans over nature [56]. Since people that defend this tradition see moral values as the main concept of environmental attitude [74] there might be so discussion if NEP actually evolved into a more evaluative conception of attitude [65];[73] that change can be observed in other attitude concepts as well: [76];[77];[78];[16]. This perspective is also corroborated by the fact that NEP findings almost doesn't correspond to those regarding the relationship between environmental attitude and ecological behavior. Environmental attitude and ecological behavior seem to be at least fairly related [47] .Since the experimental findings of the area will be shown following a certain theoretical framework; the next part will explain the structure of the theory of planned behavior. The structure involves mainly the three aspects of attitude concept previously mentioned.

A general framework: the theory of planned behavior

In the theory of reasoned action [22]and in its more recent iteration, the theory of planned behavior [3], the intention shown to perform the behavior in question is considered the precedent the actual behavior. On the other hand, intention, is related to the attitude towards performing a particular act and subjective norms (i.e. the perception of the

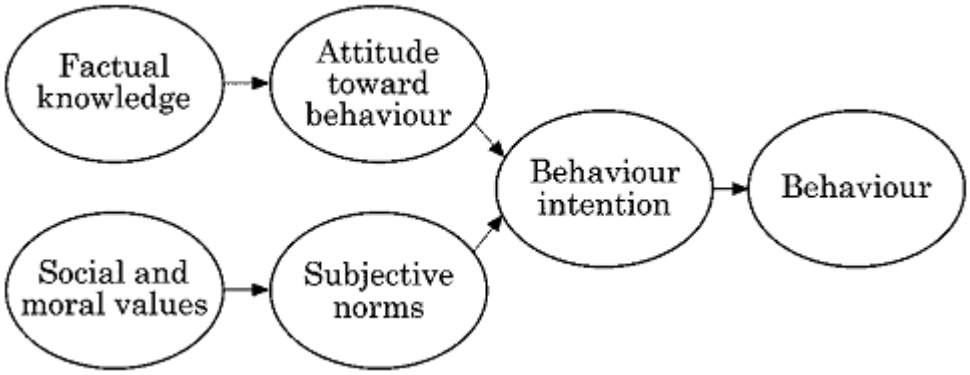
expectations of relevant others). Since attitude involves not only the evaluation of the results but predicting the odds of the result occurring, salient information or factual knowledge is a necessary precondition for any attitude [23]. As subjective norms are related with both the strength and the motivation to comply with normative beliefs, like social and moral values (i.e. what are the expectations both social and moral, which would be the prediction of the targets' subjective norms).

In picture 3, there's a graphical representations of the theory of. The theory of planned behavior includes the theory of reasoned action because it takes in to account influences on behavior that transcend people's control. If the impact determined through the idea of control, we have to take for granted two propositions:

3) the predicted behavior must be, at least partially, beyond volitional control

4) perception of control must reflect actual control upon behavior with some accuracy [24]

While the latter proposition can be seen as a flaw on the planned behavior approach, the first is often defended in the ecological domain.



Picture 3 - The theory of reasoned action

Ecological behavior seems to be easy to influence [47]. For example, the energy consumption is influenced by the outside temperature [55] and home characteristics [78],while the price of water influences water expenditure [79] , and the recycling behavior[80] is influenced by the number of people in a given household [81], house ownership [82], storage space [83] and type of residence. The possible influences community or neighborhood-related involve various political measures like ones that defend public transportation systems (allowing another solution better than to commute by automobiles), or assistance on recycling or by forcing people to pay for garbage disposal, something that decreases waste generation even more and supports recycling. Summarizing, socio-cultural limitations shape, in a way, the ecological behavior that is easier to do and which one is more difficult. Consequently, people show inconsistent behaviors, because even those that defend ecology can behave ecologically in some areas and unecologically in others [80]; [56];[84]; [75]. So, without any surprise, the theory of planned behavior, that considers behavior constraints

beyond volitional control, can be considered really practical in predicting ecological behavior. Since it not taken in consideration those constraints, the omission socio-cultural constraints [23] in the theory of reasoned action, in previous researches most probably affected the results. But on the other hand, the selection of possible socio-cultural constraints continues to be a problem, later on some solutions will be presented.

Environmental attitude, factual knowledge, values, intention and ecological behavior

In order to consider all three attitude concepts (i.e. attitudes toward the environment, the new environmental paradigm and attitudes toward ecological behavior) in one general framework (i.e. the theory of planned behavior), this framework has to take into account at least three factors: factual knowledge about the environment, social and moral values regarding environment, social and moral values regarding environment and ecological behavior intention. The theory of reasoned action, as well as the theory of planned behavior, proposes that attitude influences behavior, mediated by intention see Figure 3. Factual knowledge can be seen as a precondition of any attitude and, thus, the relationship between factual knowledge and behavior is mediated by intention as well. Moreover, subjective norms, or at least one's values, are also mediated by intention and therefore predict behavior indirectly. Given these interrelations, research findings in the ecological domain fit together quite well. [85]

Attitude effect

Considering that we can predict environmental attitude, with only one measure independently from the type of environmental attitude, the usual findings will end up showing an average level of influence between environmental attitude and ecological behavior [86]; [63]; [47]; [16]; [87]or a weak influence [88]; [71]; [83]; [72]; [69]; [89]; [79]; [70]. There are even five studies that show no influence whatsoever [90]; [91]; [80]; [82]; [81] while only one study shows a considerable influence between environmental attitude and ecological behavior [92].

Knowledge effect

Considering that the environmental attitude is dependent on the factual knowledge about the environment, there shouldn't be a strong correlation between this knowledge and ecological behavior since this influence dependent on the environmental attitude and ecological behavior intention. *So, we can justify why did several studies found either no influence between factual environmental knowledge and ecological behavior [59]; [60]; [65]; [66] or at best a moderate relationship [90]; [64]; [61]; [23]; [47]; [80]. When we see this influence, frequently it's information about an ecological behavior (i.e. knowledge about what and how something can be done) rather than, factual information about the environment that is related to ecological behavior (e.g. [93]; [71]; [94]). [85]*

Value effect

Following the theory of planned behavior, the way a person want to behave ecologically is dependent on his subjective norms[55]; [95]; [96] and his normative beliefs concerning the environment. But, this influence varies between neglectable [96]to important [88]. Also, the influence will decrease if instead of ecological behavior is taken in consideration ecological behavior intention [88]; [56], supposedly showing the mediating effect of ecological behavior intention. We can see that the environmental values parallel these findings: environmental values influence the ecological behavior intention [73]; [77]; [97]; and considering that environmental values influence the ecological behavior [73]; [77]; [78]; [74]; [70] they are most probably mediated, according to the theory of planned behavior by the ecological behavior intention.

Intention effect

Usually the most obvious effect is usually concerning the ecological behavior intention and ecological behavior. Ecological behavior intention is strongly related to ecological behavior [59]; [60]; [65];[66]; [82]; [67]or at worst moderately related [61]; [23]; [47]; [79]; [98]. Sadly, in some types of ecological behavior there can't be found any kind of correlation [67]; [99] and in at least two studies in where the "relationship between ecological behavior intention and ecological behavior appears to be small" [88]; [77]. It's quite frequent in the ecological domain that one type of ecological behavior is affected by either environmental attitude, environmental knowledge, environmental values or ecological behavior intention where others are not [63]; [72].

When we are dealing with this finding relates to measurement correspondence, this means grading related concepts on the same level of specificity. We can predict better specific ecological behaviors instead of general ecological behavior measure with environmental attitude measures [86]; [88]; [91]; [87]. But, in the end discoveries in different domains can't be compared because specific measures seem more susceptible to situational influences than to general ones. This ends up having some important methodological implications and consequences for the ecological domain.

Methodological considerations

Both the measurement correspondence and behavior influences beyond that transcend peoples control should be considered as factors when considering the relationship between environmental attitude and ecological behavior.

Measurement correspondence: general attitude and general behavior

The potential absence of correlation between environmental attitude and ecological behavior is well known [86]; [17]; [51]; [56]; [16] and won't require any more justification. We can summarize as follows: if one's environmental attitude is assessed generally, 'the behavioral

criterion should be equally general or comprehensive' [86]: p. 728. Since, highly specific measures of ecological behavior are occasionally refused as a solution because they are highly susceptible to situational influences beyond people's control [50]; [84] opposing general measures of ecological behavior, even considering that correspond with environmental attitude. Since specific measures seem to be more susceptible than general measures, general environmental attitude measures are selected as better predictors of comprehensive ecological behavior criteria [17]. Even considering that some studies show results defending the idea that there are strong relationships between general environmental attitude and general ecological behavior measures [92]; [16]others do not [88]; [77]; [72]; [69]; [75]; [87]; [70]. This conflicting data about the influence felt between general environmental attitude and general ecological behavior can be justified as the result of difficulties in measuring the general ecological behavior we can see this on [20]. Sometimes, some doubts rise when concerning the basis of the general measure [49]; [80]. But, we can find at least one general measurement approach that takes in to account various different behaviors, that ends up negating situational influences beyond people's control (see [20]).

Consideration of influences beyond people's control

As I said before, both environmental attitude and ecological behavior can be influenced by reasons that transcend people's volitional control. In this way, situational factors such as economic constraints, social pressures and opportunities to choose different actions ([47]: p. 7) can influence the attitude.

As we consider, recycling opportunities influence the recycling behavior ([83]; [56]; [54]). We can take into consideration these situational influences following three different methods. We can start by analyzing the one called perceived control, can be considered and indicator of control and we can use it in order to predict the ecological behavior, it was proposed by Ajzen and Madden in 1986 [24]. We are going to analyze the moderators of the relationship between environmental attitude and ecological behavior. Since moderators consist of conditional aspects in a predetermined relation, and we can chose as moderators involuntary behavior constraints that influence the relationship (e.g. residential area or season). Finally, we can establish the Rasch-scale as an ecological behavior measurement, enabling us to give values to the ecological behavior difficulties being used as a result scale.

Perceived control

There are various concepts of perceived control when we think about the ecological domain [93]; [72]; [67]; [100]; [70] as an example we can see the internal locus of control [90]; [101]; [102]; [71]; [47]; [80]; [81]; [94], self efficacy [95]; [16]and feelings of powerlessness [103]. None of them, however, indicate people's actual control as proposed by [24]. Rather, they represent different predictors of either ecological behavior [93]; [90]; [103]; [71]; [47]; [80]; [16]; [67]; [81]; [94]; [70]or ecological behavior intention [101]; [102]; [95]; [100]. Unfortunately, the relationship between perceived control and ecological behavior is inconsistent and ranges from slightly negative [70] to nonexistent [80]; [81]to very positive [67].

Moderators

There are many moderators that can influence both the environmental attitude and ecological behavior relationship those can be: gender [65];[66], socio-economic status [96], mode of behavior assessment [47], group membership environmentalists vs nonenvironmentalists: [47], income [92], access to recycling programs [104], season [105]and nationality [106]. This moderators represent different sorts of involuntary, socio-cultural behavior constraints. Frequently, doubts about their scope remain in question: if all or just some ecological behaviors influence the ecological behaviors? Since moderator effects point out situational, socio-cultural influences seem difficult to explain or require more theoretical explanations cf. [107] ending up raising more questions than they answer and, in this way, remaining somewhat problematic. Also, uncertainty in the choices might end up influencing empirical findings. This can be seen since the moderators use on one study aren't the same used on other studies.

A general ecological behavior measure

Since the probability of a behavior takes into account the influences uncontrollable, a good way to rate the ecological behavior is in fact by the odds of it occurring. For example the rate with which a person commutes can depend on some influences that he can't control, (i.e. weather, traffic and possibility of using an automobile). Also, many other factors that we can't control influence each behavior differently making actually executing them differently hard.

In this way, some behaviors appear easier to do. A good example is the fact that, if the recycling bins are close by it's easy to recycle. So, we have to take in to account the influences beyond people's control in two different ways by predicting the personal odds (i.e. one's tendency of behaving ecologically), also the odds of anyone carrying out a certain behavior (i.e. behavior difficulty). The General Ecological Behavior (GEB) scale predicts general ecological behavior by considering different ecological and prosocial behaviors. To each behavior corresponds a difficulty to be overcome, that, in turn, ends up being a probability of all the constraints beyond people's control. The fewer constraints are taken into account the easier the behavior is to have. A certain behavior difficulty is predicted by taking into account the number of people who behave accordingly (i.e. the probability that anyone will behave that way regardless of his or her tendency to behave ecologically). An individual tendency to act ecologically is predicted by taking into account the number of ecological behaviors he or she has done (i.e. the probability that somebody will behave ecologically) since behaviors vary in difficulty.

Since one of the ways to know the individual ecological behavior takes into account the tendency to behave ecologically and the behavior difficulties, but individuals can, in a certain way, act inconsistently across different ecological behaviors. A person, for example, that frequently acts ecologically on various and different behaviors, may end up not recycling the newspapers, even considering that it's an easy behavior. On the other hand, some other person that is considered mostly as unecological can, by some reason, not drive an automobile, a behavior that is frequently considered as hard to carry on. In this way this situations may be caused by different socio-cultural limitations transcending peoples actual

control, situational influences are represented in this behavior measure in two different ways for more details see [20].

Hypotheses

The ability to predict environmental attitude has 3 main limitations, especially when considering ecological behavior:

1) the lack of a unified attitude concept

2) the lack of measurement correspondence between attitude and behavior on a general level

3) the lack of considerations of situational behavior constraints beyond people's control

Kaiser proposed using adaptation of the theory of planned behavior by Ajzen in order to organize environmental attitude concepts. Also, in order to overcome the methodological limitations he applied a probabilistic measurement approach.

Kaiser defined as the conceptual basic structure for the theory of planed behavior as the environmental knowledge, environmental values and ecological behavior intention. He used the three most frequently used attitude approaches in environmental psychology: attitude towards the environment, attitude towards ecological behavior and the NEP. Also, environment attitude and ecological behavior are supposed to have a stronger relation since a general ecological behavior measure was adopted. This measure evaluates the behavior using the behavior difficulties and behavior tendencies. Kaiser predicts that the influence between general attitude and general behavior are supposed to remain constant even on ideologically distinct groups of people. In order to verify this, two groups were defined each one with different ecological ideologies. Kaiser in his paper[85] analyzed this predictions:

1) environmental knowledge and environmental values are significant preconditions of ecological behavior intention see Figure 1

2) ecological behavior intention affects ecological behavior strongly if both of them are assessed rather generally and if the ecological behavior measure considers situational behavior constraints

3) all relationships between the three environmental attitude concepts (i.e. environmental knowledge, environmental values and ecological behavior intention) and between ecological behavior intention and ecological behavior are not moderated by ideology rather they can be generalized across ideologically heterogeneous groups

Method - Participants and procedures

The data that shown next, corresponds to a survey that Kaiser took from two distinct Swiss transportation associations, each with different ideologies. While the first hopes to develop a transportation system that has the least negative impact on humans and nature as possible, the other is in fact the automobiles drivers' interests. In order to take into consideration as much as possible the diversity, sub-categories are made like primary language (French, Italian and German) and type of residential area (city, suburb and village). There was a participation of around 27.4 % this corresponds to 1643 participants. This survey consisted of three questionnaires: the first was sent out during December 1993, and 1371 people 83.5% completed it ([108]; [57]). In the following questionnaire the targeted participants were those who took part in the first questionnaire. The second questionnaire was mailed in May 1994, and 1189 there was a participation of about 86.7%. The final survey, took part in November 1994, and targeted only the German speaking subgroup from the first study. Take in to account that the German speaking subgroup in both of the previous surveys consisted of 579 42.2% of the total sample and 438 36.8%, respectively. After 445 returned questionnaires 82.0% completed questionnaires. Participants' 62.5% male median age was 45.5 years, M=46.6, ranges20-82.We should take into consideration that there was a auto selection process of the people more ecologically- concerned thus high participation rate within the pool. There was a smaller representation of the automobile drivers' association about 25.8% of the sample versus the 74.2% from the association promoting a more ecological transportation system. So we can say that the sample appears to tend towards the more ecologically concerned participants. Kaiser considered that for his study that considering the wide variety of participants corresponded to acceptable diversity, concerning the ecological concern. Considering that it's the relationships and not means that are tested, the sample bias was considered of minor importance. Also, the possibility of generalization of the proposed relationships will be analyzed by statistical means, this is what fit statistics are used for.

Measures

The surveys were made by Kaiser around a Social Desirability scale, a General Ecological Behavior measure, and three scales that represent the environmental attitude related concepts.

The Social Desirability SD scale presented by Amelang and Bartussek 1970 [109] consists of 32 items. Fourteen items had to elicite a 'yes' response e.g. 'I never claim to know more than I actually do' and 18 items a 'no' response e.g. 'I have taken advantage of people in the past' to contribute to the SD sum score. [85]

Since Kaiser wanted the ecological behavior items to be consistent the answers that initially were true/false were changed into a yes/no format.

Missing values n=109; 0.8% were treated as if participants answered in a nonsocially desired way. The General Ecological Behavior GEB measure consists of 38 items representing different types of ecological behavior and some nonenvironmental, prosocial behaviors as well.

A yes/no response format for these items was used. Negatively formulated items were reversed in coding. Missing values n=80; 0.5% were handled as 'no' responses in general assuming missing values represented participants' doubt, an indicator of not behaving alike in general. The GEB measure has been calibrated as an unidimensional Rasch- scale [20] based on item response theory Wright & Masters, 1982 [110]. Additionally, all attempts to validate the GEB measure with criterion-related self-reported data and with observed behavioral data were promising see Kaiser, 1998 [20]. The GEB items and the 32 SD items were distributed randomly throughout the questionnaire. [85]

Between the first and the second studies the items used to evaluate the three environmental attitudes were reevaluated [108]; [57]; [99]. The scales that were reevaluated were:

- Environmental Knowledge (EK)
- Environmental Values (EV)
- Ecological Behavior Intention (EBI)

Kaiser ended up using a Likert scale that with values that go from 1 to 5, meaning agree to disagree. He didn't take in to account the fact of the 28 items only 3 were negatively turned, even if there was a possibility to be biased (i.e. acquiescence response set). But, considering that the 10 knowledge items that represent the EK scale, were distributed randomly throughout a total of 24 knowledge items. All seven value items, which represent the EV scale, were distributed randomly throughout a total of 13 value items. And, all 11 intention items were grouped together in the questionnaire. Negatively formulated items were reversed in coding.

In order to assure the three-factor structure of the first study a principal-factor analysis PFA (see Table 1). Step by step communality estimates were deduced by using the highest correlation of each variable with any other variable as a starting value.

The final solution was varimax rotated. Three hundred and ninety-one participants remained in the analysis; fifty-four people were excluded because of missing values. Twenty-eight items with a total of 49.1 % explainable variance remained in the analysis. The final three-factor solution accounted for 74.9 % of this remaining variance. Factor loadings of the varimax rotated final solution can be seen in Picture 4.[20]

After rotation, the explained variance was attributable to each of the three factors as follows:

- EK=31.9 %
- EV=24.4 %
- EBI=43.7 %

The correlation of the three factors ended up being negletable

- p= 0.05
- R^2 =1.2%
- r (EK-EV) = 0.11
- r (EK-EBI) = 0.08
- r (EV-EBI) =0.09

These low level relationships between EK, EV and EBI are a result of using varimax rotation. The study corroborated the statistical independence that is needed to check their empirical interrelations. Usually, in the information of all 28 items there's a relation with the pollution as we can see in Picture 4.

Kaiser used Cronbach's alpha in order to determine the internal consistencies of the three factors:

α(EK) =0.84 n=418

α(EV) =0.73 n=425

α(EBI) =0.85 n=423

In further analyses, the values of EK, EV and EBI are a result of the mean of the constituent items. Kaiser restricted the results would be only taking in consideration if the participants had given answers to at least half of the items for each factor. And, by analyzing the correlations between factor score and mean values factors we can see that they are good approximations (n=391):

- r (EK) =0.89
- r (EV) =0.90
- r (EBI) =0.95

Kaiser considered that, the mean values [n (EK) =441, n (EV) =440, n (EBI) =442] could be used instead of the factor scores n=391, so, this data could be used in further analyses.

Item		Original	Replication
Knowledge (EK): I agree that ...			
1.	... melting of the polar ice caps may result in a flooding of shores and islands.	0·46	0·70
2.	... fossil fuels (e.g. gas, oil) produce CO_2 in the atmosphere when burned.	0·42	0·67
3.	... all living beings (micro-organisms, plants, animals, and humans) are interdependent with one another.	0·37	0·62
4.	... poisonous metals are introduced into the food chain, for instance, via ground water.	0·37	0·50
5.	... ozone near the ground may cause respiration problems.	0·37	0·47
6.	... a change in climate caused by increased levels of CO_2 in the atmosphere is called the greenhouse effect.	0·46	0·47
7.	... poisonous metals remain in the human body.	0·35	0·47
8.	... the world climate will probably massively change if CO_2 continues to be emitted into the atmosphere in as huge amounts as it is now.	0·56	0·45†
9.	... a reduced number of species may interrupt the food chain, affecting some subsequent species in the chain.	0·45	0·40
10.	... the greenhouse effect does not result in the melting of glaciers in central Europe.*	0·34	0·39
Values (EV): I agree that (meaning: I admit that) ...			
1.	... all things, whether humans, animals, plants, or stones have the right to exist.	0·58	0·72
2.	... animals should have legal rights.	0·51	0·59
3.	... all organisms' lives are precious and worth preserving.	0·52	0·57
4.	... nature must be preserved because God or another supernatural force is part of it, even in its nonliving aspects.	0·55	0·47
5.	... in general, raising animals in cages should be forbidden.	0·39	0·41
6.	... for everything that I do, including deeds affecting the environment, I am responsible to a supernatural force, for instance God.	0·39	0·36
7.	... the earth's value does not depend on people; it is valuable in itself.	0·37	0·34
Intention (EBI): I agree that (meaning: I admit that) ...			
1.	... I support raising parking fees in cities.	0·60	0·74
2.	... I am ready to pay environmental taxes (e.g. raising fuel or automobile taxes).	0·59	0·71
3.	... I support speed limits on freeways [100 k.p.h. (62·5 m.p.h.) and 80 k.p.h. (45 m.p.h.) where freeways cross residential areas].	0·61	0·69
4.	... I support efforts to create automobile-free inner cities.	0·59	0·65

TABLE 1 — CONTINUED

Item	Original	Replication	
5.	... I would prefer to drive only if absolutely necessary (i.e. no other mode of transportation is available).	0·59	0·53
6.	... I would prefer not to drive to work any longer.	0·56	0·52
7.	... I would prefer to be able to go shopping without my automobile.	0·56	0·48
8.	... I will stop the engine at red lights in the future.	0·47	0·43
9.	... I will still need by automobile in the future.*	0·43	0·43
10.	... my next automobile will be small and as ecologically sound as possible.	0·46	0·41
11.	... I will travel by automobile or by airplane during my vacations.*	0·42	0·40

Picture 4 - Twenty-eight items and their factor loadings grouped into three factors: environmental knowledge EK, environmental values EV and ecological behavior intention EBI

Analysis

Following the factor loadings of the PFA, the environmental attitude related scales EK, EV and EBI were divided into two balanced sub 10 scales EK1, EK2, EV1, EV2, EBI1, EBI2 that were used as input variables for the structural equation analyses. After further analysis Kaiser concluded that the reliability of the indicators was different. For example, the reliability of EV2 turned out to be quite low see Figure 2.

All structural equation models were assessed using the Maximum Likelihood method cf. Joreskog & Sorbom, 1993 [25]. Unless otherwise indicated, the correlation matrix was used as the input matrix. See Appendix 2 for the correlation matrix, variable x means M, and their standard deviations (S.D.).

Results

The results are shown in three parts. Initially, constructs were analyzed for social desirability effects. Then, both the hypothesis 1 and hypothesis 2 were tested (EBI were established as dependent of EK, and of EV, and, in turn, determines GEB). Finally, hypothesis 3 was scrutinized (can hypotheses 1 and 2 be generalized even across ideologically heterogeneous groups).

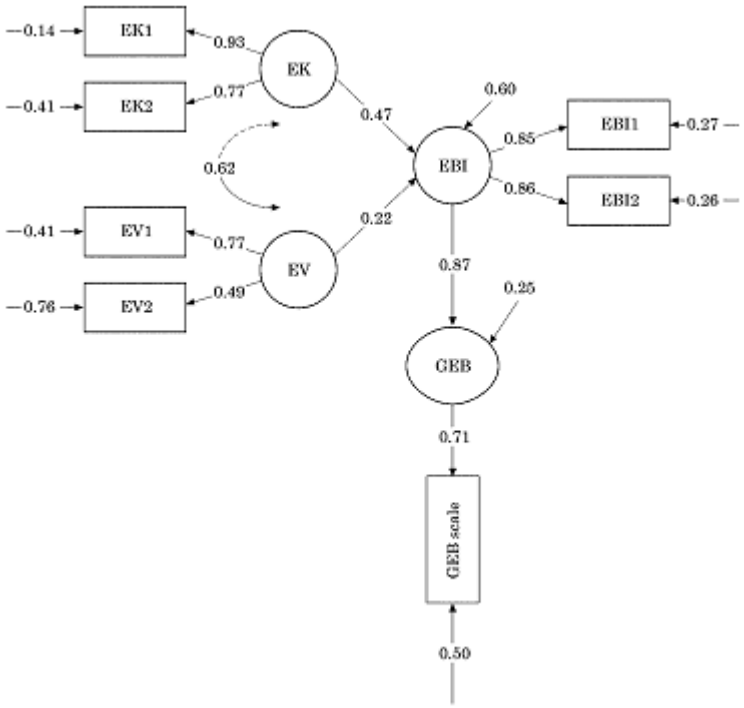
Social desirability effects

Kaiser considered the four measures, EK, EV, EBI and GEB, as important. Since the preliminary testing for social desirability (SD) effects revealed, didn't show a lot of sensitivity to S.D. The correlation was either insignificantly (p=0.05; r (S.D.-EV) =0.01; n= 440) or marginal, as shown by the amount of explained variance (R^2), although significantly (p=0.05) with S.D.:

$r(\text{S.D.}-\text{EK}) = -0{\cdot}13, \quad R^2 = 1{\cdot}7\%, \quad n = 441$
$r(\text{S.D.}-\text{EBI}) = -0{\cdot}13, \quad R^2 = 1{\cdot}7\%, \quad n = 442$
$r(\text{S.D.}-\text{GEB}) = -0{\cdot}10, \quad R^2 = 1{\cdot}0\%, \quad n = 443.$

Environmental attitude and ecological behavior

By analyzing the results we can see that EBI is a function of EK and of EV. On the other hand, GEB revealed that both can be, without any model modification, accepted from an empirical point of view (χ^2 =17.86, df. =11, p=0.085, non- normed-fit-index (NNFI) =0.99, root-mean-square- error-of-approximation (EMSEA) = 0.038). This model was tested with 436 participants and the model is seen in Picture 5.



Picture 5 - General ecological behavior GEB predicted by ecological behavior intention EBI provided by the proposed GEB measure see Kaiser, 1998.

We can obtain 40% of the variance of EBI using this two determinants EK (β=0.47) and EV (β=0.22). These two indicators of EBI are also correlated with another one (r=0.62). We should remember that these experimental findings done by Kaiser were based on independent constructs. This is so, because, the fact of the scales not being related could be forced statistically (e.g. varimax rotation; see Method). With one variable EBI (β=0.87),we can explain about 75% of the variance of GEB. As Kaiser expected, as result of GEB's scale unreliability the importance of EBI in determining GEB was attenuated (ME(GEB scale) =0.50. So, if we don't correct the measurement error and assume a perfect GEB measurements (β (GEB-GEBscale) =1.0), the weight of explained variance of GEB end up dropping to 38%

Transportation association as a moderator

Kaiser was aware that the different participation rates of the members of the two transportation associations would mean that sample was biased towards more ecologically-concerned participants. So, being concerned with the possibility to generalize of his findings, (cf. [47])he compared both groups. Covariance matrices were used as input matrices.

"This comparison supported, on the one side, the generalizability of the proposed model. On the other side, it pointed to two moderation effects caused by the association membership."

A model was devised to take that into account that fact that there was a diference in the reliabilitu of theyr EBI measures, as well as in both the variances of EK and EV and the strength of the relationship between EK and EV (χ^2 =61.45, df.=32, p= 0.001, NNFI=0.95, RMSEA=0.046). In order to adapt the modifications were needed, this was observable thanks to the NNFI, a sample size independent measure.

The Association membership appears to have two major impacts on the model. First, four modifications refer to reliability indicators of the EBI measures:

(1) β(EBI-EBI1)

(2) β (EBI-EBI2)

(3)ME(EBI2)

(4) r (ME(EBI1)-ME(EBI2)) -> measurement error correlation

Analyzing all this factors, we can see that the automobile driver's interest association, the assessment of EBI was much more accurate than for the ecological transportation association. As we measure EBI in the second group there seem to be influences beyond the scope Kaiser's study. The other three modifications in Picture 6, "differential (i.e. free variances for EK and EV) as well as the difference in the strength of the relationship between these two constructs, point to differences in the homogeneity of the two associations involved regarding EK and EV."[85]

	Association	
	Automobile driver's interest ($n = 111$)	Ecological transportation ($n = 322$)
β(EBI–EBI1):	0·85	0·58
β(EBI–EBI2):	0·93	0·43
ME(EBI2):	0·14	0·82
r[ME(EBI1)–ME(EBI2)]:	—	0·27
Variance (EV):	Free	Free
Variance (EK):	Free	Free
r(EK–EV):	0·63	0·39

Picture 6 - Seven differences for members of the ecological transportation and members of the automobile driver's interest

Behavior-Based assessment of environmental motivation

Psychology, recently due to discoveries pointing out an attitude–behavior inconsistency, there has been a slow shift away from the idea that the mental state is tangible in a person's evaluative statements ([111]). In other words, nowadays it's believed that the peoples' motivations are more obvious when analyzed the verbal claims instead of individual actions.

As we will see in my work further down, I took into considerations in my surveys both the peoples verbal claims and actions as a way to have a final image of the outcome.

Kaiser took into consideration the critics (e.g. [112]; [113]), and the absence of co-relation between attitude and behavior (e.g. [26]; [114]).

" So, verbal claims instead of conservation activities are employed in the assessment of individuals' environmental motivation; sometimes called environmental attitude and sometimes called concern (see e.g. [115]). In opposition to this state-of-the-art but in line with

Campbell's original conception, Kaiser and his colleagues have developed an alternative environmental motivation measure, which consists of a composite of various conservation behaviors (i.e. the General Ecological Behavior scale; e.g. [20]; [21])."[85]

Behavioral Means to the Conservation Goal

Kaiser defined conservation behaviors as behavioral means by each of us hopes to achieve his conservation goals ([21]). So, it's understandable that we can measure a person's motivation, by seeing how much this person is willing to give up, in order to achieve his conservation goals.

Prudent Selection of Means

Kaiser in his article gave a special importance to the fact that nowadays even people that want to contribute to the environment their contributions are dependent to the level of effort they imply. In this way he meant that, within the various contributions for the environment like, using the bike for commuting, not using the drier or not using detergents. This means, each behavior has implied in itself a certain degree of effort or expenditure of certain personal resources (time, money, space, or even resist social pressure). Considering that people have options this means that each one will take into consideration the options he has and find his own optimal solution.

Kaiser's use of Rasch model was defined as a function of two factors and those were:

c) a person's environmental motivation

d) the composite of all the costs involved in the realization of a particular act

Kaiser and colleagues have shown that the "Rasch model" mathematically describes this functional relationship adequately (e.g. [20]; [21]).

Shared Preference for Means

The function that represents the Rasch model is:

$$p(x_{ki} = 1|\theta_k,\delta_i) = \frac{\exp(\theta_k - \delta_i)}{1 + \exp(\theta_k - \delta_i)}$$

Following the Rasch model the variables are called:

p->Probability

k->Person

i ->Behavior

δ_i->Behavior's realization costs

θ_k->Person's commitment

e-> Euler's constant (2.718)

We should take into consideration the fact that in this model, people's environmental motivation and behaviors are taken into account. In other words, this model enables us to predict the odds or the level of acceptance of a certain behavior. This can be used both in small or big scale.

Since the Rasch model takes into account just one parameter, only analyses the behaviors on considering the importance given by the persons. So we can pick up what is considered as an individual environmental motivation and re-state it as a list of behavior means that a group of persons actually uses to achieve the conservation goal. We can only make this list if the realization costs of a behavior are taken into account which gives us the level of popularity of an action and we need to assume that everyone will be influence in a similar way. Kaiser took a series of tests where he determined if Rasch models axioms could be taken trusted in his case and achieved some interesting results and conclusions. *According to this misconception, the behavior relevance of individual motivation is anticipated to depend on the behavioral costs involved* (e.g. [26]).

Unmoderated Efficacy of Motivation

Kaiser in his article stated that *"in psychology, we traditionally favor interactionist perspectives in which different motivation levels (to strive for personal goals) are expected to be differentially effective depending on the behavioral costs (cf. [116]). Schultz and Oskamp ([117]), for example, argue that as a behavior becomes more expensive, literally and figuratively speaking, the motivational factor will have stronger relevance for that behavior."* From Kaiser's understanding we can see that the environmental attitude has a greater importance on behaviors as the degree of difficulty increases.

There many ideas about the relation between environmental attitude and behavior, some believe that it's linear [117],some monotonic negative[118] and others curved [54].

Kaiser and Schultz[119] defended that environmental attitude on behavior did not depend on the behavioral costs. They defended that there are limits to the variability of attitudes, they supported they're claims on the theory of planned behavior, where a person's overall motivation (i.e. his or her intention to act) typically does not interact with the behavioral costs in its potential to affect behavior (e.g. [18]; [24]; for an exception with fairly trivial effect sizes of about 2 to 3 % additionally explained variance, see [120]).

Country-Specific Realization Conditions

Kaiser also gave a certain degree of importance not only to the motivational part but took into consideration the subjective influence on decisions [27], so, the socio-cultural circumstances will in an uncertain way influence the results of the intervention. This means that it can be done if differential realization costs are taken into account in the determination of the environmental motivation of people. He had success in proving this with different sets of behaviors (e.g. [28]; [29]).

"Until now, this research has shown that under fairly similar conditions environmental motivation translates into an array of more or less preferred behaviors and, thus, a range of behavioral costs that individuals must overcome in a systematic manner in their efforts to accomplish their personal conservation goals."[27]

When people are deliberating if they are going to act, the realization costs are taken into account, even more, this costs affect everyone.

This means, the preferred behavioral means to achieve the conservation goal can only be used within similar conditions, in other words this conditions aren't easily transposed to other countries(e.g. [28]; [27]).

We can see that it's easy to not use a car in a Swiss Urban environment on the other hand if you are in Sweden it's not that easy to make that choice. Another example, is heating and consumption in Central and Southern Europe differences.

In other words, when persons are exposed to highly incomparable obstacles and opportunities, which are imposed on them by the socio-cultural, geopolitical, and/or climatic conditions, the consequence is variation in preference for behavioral means according to these realization conditions.

McKenzie-Mohr

Fostering sustainable Behavior Through Community-Based Social Marketing

Psychology has a central role to play in speeding the transition to a sustainable future, because a central aspect of sustainability is widespread behavior change. To date, however, most programs promoting sustainable behavior have featured information-intensive campaigns that make little use of psychological knowledge. Community-based social marketing is an attractive approach in which promoters identify the activity to be promoted and barriers to this activity and then design a strategy to overcome these barriers, using psychological knowledge regarding behavior change. The strategy is piloted to test it's a broader scale. Unlike many information-intensive campaigns, community-based social marketing has been shown to have a much greater probability of promoting sustainable behavior. Tow case studies are provided to illustrate the approach and its possible results.

"That which is not good for the beehive cannot be good for the bees" – Marcus Aurelius [5]

Community-based social marketing

In Canada, people developing programs to promote sustainable behavior are increasingly using a hybrid combination of psychology and social marketing (see Geller[30] for an earlier integration of psychology and social marketing).

In contrast to the conventional approaches just reviewed community-based social marketing has been shown to be quite effective at fostering sustainable behavior([31]).Its effectiveness is due to it's pragmatic approach, which involves the following steps: carefully selecting an activity to be promoted; indentifying barriers to the activity; designing a strategy to overcome these barriers, when possible; piloting the strategy with a small segment of a community; and finally; evaluating the impact of the program once it has implemented across a community.

Selecting Behaviors

Frequently, it's possible to reach an environmental objective, such as reducing public sector carbon dioxide emissions or household waste, through a variety of action. For example when individuals respond to encouragement to use mass transit, to insulate their homes, or to install programmable thermostats, carbon dioxide emissions can be reduced. Waste reduction can be promoted through source reduction, reuse, or recycling. Although each of these activities is worth promoting, sufficient resources often do not exist to pursue them all. The decision of which behavior(s) to promote should be based primarily on the answer to three question. First, what is the potential of an action to bring about the desired change? That is, how large a reduction in carbon dioxide emission of the municipal waste stream is achievable through each of the actions that might be promoted? Second, what are the barriers associated with each of the potential actions, and do the resources exist to overcome these barriers? Third, what class of behavior is to be promoted?

It is useful to distinguish between two classes of environmentally related behavior: one-time and repetitive actions.

One-time actions, involve purchasing more resource-efficient equipment (e.g. an efficient furnace or car or a low-flow toilet), whereas repetitive actions involve initially changing behavior and then sustaining that change over time (e.g., setting back the thermostat each night or bicycling to work rather than driving). These two classes of behavior differ both in their impact on resource consumption and in the ease with which they can be altered [121]; [122]. As a result, in many of the cases in which barriers had not been identified, the delivered program produced little or no behavior change.

Identifying Barriers

Barriers to an activity can be internal to an individual (e.g., lack of knowledge of how to install a programmable thermostat) or outside the individual (e.g., absence of convenient mass transit system), Further, multiple barriers may exist for any activity, and these barriers appear

to be activity specific [32]; [33].For example, what precludes someone from installing additional insulation in his or her attic is quite different from what prevents his or her installation of a programmable thermostat or participation in backyard composting. Consequently, the development of an effective program needs to begin with identifying barriers. This is true for one simple reason: It is difficult, if not impossible, to design an effective program to promote an activity without first knowing what inhibits the public from engaging in the activity to be promoted. Yet, this step is often skipped. In an evaluation of Canadian environmental programs, reviewers found that most program developers had neither determined the environmental impact of the behavior to be promoted nor investigated the barriers to that activity[31].As a result, in many of the cases in which barriers had not been identified, the delivered program produced little or no behavior change.

Designing Programs

Once barriers have been identified and prioritized, it is possible to develop a sound social marketing strategy to overcome those barriers. For example, barriers to proper tire inflation were identified through a national survey of Canadians ([34]).Data such as these make the development of a sound strategy substantially easier. By identifying and prioritizing barriers to tire inflation, the program designers were able to propose a strategy to overcome these barriers that had a much higher likelihood of success than if this preliminary research had not been conducted.

The development of a sound strategy depends on carefully identifying ways to overcome the important barriers. In the above case , the fact that memory was the most important factor in distinguishing frequent from infrequent tire checkers suggested that prompts as gas stations. Reminding motorist to check their tires and providing information on how to do so – might significantly increase tire checking. (In particular providing women with this requisite knowledge would be vital).further, because the lack of a tire gauge was significantly related to motorists not checking their tires, having gas stations lend tire gauges to customers might overcome this barrier.

Examples of Behavior-Change Tools

Commitment

When an individual agrees to an initial small request, the likelihood that he or she will subsequently engage in a more substantial activity increases dramatically- the so called “Foot in the door effect”. Commitment techniques have been used to foster a variety of activities that favor the environment ([41]). For example bus ridership has been increased using commitment ([42]), as has household energy efficiency ([43])

Prompts

A variety of activities that promote sustainability are often neglected, simply because people forget to engage in them. For example the repetitive action such as closing blinds on warm days , turning down the thermostat , checking tire air pressure , turning off an idling engine are all activities that many individuals are willing to do if they simply remember to do

so. In such case, prompts can be an effective tool for encouraging action. A prompt is a visual or auditory aid, which reminds people to carry out an activity that they might otherwise forget ([123]).Prompts have been used extensively in the area of waste reduction and gave frequently been demonstrated to be very effective. For example, the introduction of a prompt reminding people what types of paper could be recycled was shown to increase recycling capture rates by up to 54%([124]).

Because external barriers are likely to vary dramatically among communities, program designer attempting to create successful strategies will need to determine the external, non-psychological barriers that exist for each community and implement an appropriate program to remove these barriers. In doing this, there are many areas of expertise will be useful to remove the external barriers to change the behavior.

Piloting and Evaluation

A pilot study allows program designers to test various strategies against one another to determine the most cost- effective strategy, to refine a strategy until it works effectively, and to avoid costly expenditures by not implementing ineffective programs that will have little or no return on investment. Additionally, performing a pilot can return on investment. Additionally, performing a pilot can be an essential step unconvincing funders that a program is worth supporting.

Evaluation is the final component of a community based social marketing strategy. In evaluations, measure of behavior change or consequences of behavior change (e. g., reduced residential energy use) are preferable over indirect and less reliable measures, such as self. Reports or increases in awareness. Evaluation studies can provide information that is valuable for further funding.

Important websites:[35],[36]

Conclusion

Although a cornerstone of sustainability is behavior change, it has yet to make a major contribution to the design and delivery of programs to foster sustainable behavior. Not only can psychologists assist with program design and evaluation, but they can also provide reliable information regarding barriers to activities.

Appendix 2

E C S Building

Management

1) Are you concerned with the current increase price of oil?
2) What about the gas prices?
3) How much energy you think UMBC spends per year?(4389900MJ(fuel oil)+ 277200000MJ(electric)+ 263764591MJ(nat gas))
4) Do you have any kind of environmental concerns?
5) What have you done so far to address them?
6) Considering you position at UMBC are you interested in make a joint contract with all other building managers to in order to decrease the carbon footprint of the university?
7) What about just increasing the energy efficiency of the university?

http://www.surveymonkey.com/s/WMRN67M

Consumers

1) Are you concerned with the current increase price of oil?
2) What about the gas prices?
3) Do you feel comfortable with the temperature of the university or do you think it's too high when the temperature outside is low and too low when the temperature outside is high?
4) How much energy you think UMBC spends?
5) How much energy your lab spends per year?
6) Do you have any kind of environmental concerns?
7) What have you done so far to address them?
8) Do you forget to turn of the machines and lights when you leave the lab/classroom?
9) Are you willing to accept changes in the way the university looks?
10) If you had reminders you think people would remember more often to do those things?

http://www.surveymonkey.com/s/WMJ9NGM

Commons

Management

1) Are you concerned with the current increase price of oil?
2) What about the gas prices?
3) How much energy you think UMBC spends per year?
4) Do you have any kind of environmental concerns?
5) What have you done so far to address them?
6) Considering you position at UMBC are you interested in make a joint contract with all other building managers to in order to decrease the carbon footprint of the university?
7) What about just increasing the energy efficiency of the university?

http://www.surveymonkey.com/s/WM8Y95M

Consumers

1) Are you concerned with the current increase price of oil?
2) What about the gas prices?
3) Do you feel comfortable with the temperature of the university or do your think it's too high when the temperature outside is low and too low when the temperature outside is high?
4) How much energy you think UMBC spends?
5) How much energy your lab spends per year?
6) Do you have any kind of environmental concerns?
7) What have you done so far to address them?
8) Do you forget to turn of the machines and lights when you leave?
9) Are you willing to accept changes in the way the university looks?
10) If you had reminders you think people would remember more often to do those things?

http://www.surveymonkey.com/s/WTMKKK5

Library

Management

1) Are you concerned with the current increase price of oil?
2) What about the gas prices?
3) How much energy you think UMBC spends per year?
4) Do you have any kind of environmental concerns?
5) What have you done so far to address them?

6) Considering you position at UMBC are you interested in make a joint contract with all other building managers to in order to decrease the carbon footprint of the university?
7) What about just increasing the energy efficiency of the university?
8) Are you aware that the light in the library is on all night because of security reason? You think it's reasonable?

http://www.surveymonkey.com/s/WM6JTW6

Consumers

1) Are you concerned with the current increase price of oil?
2) What about the gas prices?
3) Do you feel comfortable with the temperature of the university or do your think it's too high when the temperature outside is low and too low when the temperature outside is high?
4) How much energy you think UMBC spends?
5) How much energy your lab spends per year?
6) Do you have any kind of environmental concerns?
7) What have you done so far to address them?
8) Are you willing to accept changes in the way the university looks?
9) If you had reminders you think people would remember more often to do those things?
10) Are you aware that the light in the library is on all night because of security reason? You think it's reasonable?

http://www.surveymonkey.com/s/WMHWP39

Walker Ave Apts

Management

1) Are you concerned with the current increase price of oil?
2) What about the gas prices?
3) How much energy you think UMBC spends per year?
4) Do you have any kind of environmental concerns?
5) What have you done so far to address them?
6) Considering you position at UMBC are you interested in make a joint contract with all other building managers to in order to decrease the carbon footprint of the university?
7) What about just increasing the energy efficiency of the university?

http://www.surveymonkey.com/s/WHPLWGB

Consumers

1) Are you concerned with the current increase price of oil?
2) What about the gas prices?

3) Do you feel comfortable with the temperature of the university or do you think it's too high when the temperature outside is low and too low when the temperature outside is high?
4) How much energy you think UMBC spends?
5) How much energy your room spends per year?
6) Do you have any kind of environmental concerns?
7) What have you done so far to address them?
8) Do you forget to turn off the appliances and lights when you leave the room?
9) Are you willing to accept changes in the way the university looks?
10) If you had reminders you think people would remember more often to do those things?

http://www.surveymonkey.com/s/WHGJQ6V

Appendix 3

	Are you concerned with the current increase price of oil?									
	ESC Building		Commons		Library		Walker Ave Apts		Total	
	M	C	M	C	M	C	M	C	M	C
yes	100%	70%	100%	70%	75%	53%	100%	90%	93%	69%
no	0%	30%	0%	30%	0%	20%	0%	10%	0%	25%
Non participant	0%	0%	0%	0%	25%	27%	0%	0%	7%	6%
	What about the gas prices?									
	ESC Building		Commons		Library		Walker Ave Apts		Total	
	M	C	M	C	M	C	M	C	M	C
yes	75%	70%	75%	70%	75%	60%	100%	100%	79%	72%
no	25%	30%	25%	30%	0%	13%	0%	0%	14%	22%
Non participant	0%	0%	0%	0%	25%	27%	0%	0%	7%	6%
	How much energy you think UMBC spends?									
	ESC Building		Commons		Library		Walker Ave Apts		Total	
	M	C	M	C	M	C	M	C	M	C
5	25%	5%	25%	30%	25%	13%	50%	20%	29%	17%
55	0%	10%	0%	20%	0%	20%	50%	30%	7%	18%
555	50%	55%	50%	20%	25%	20%	0%	50%	36%	35%
5555	0%	30%	0%	30%	25%	13%	0%	0%	7%	22%
Non participant	25%	0%	25%	0%	25%	33%	0%	0%	21%	8%
	Do you have any kind of environmental concerns?									
	ESC Building		Commons		Library		Walker Ave Apts		Total	
	M	C	M	C	M	C	M	C	M	C
yes	75%	90%	75%	75%	75%	53%	100%	80%	79%	75%
no	0%	0%	0%	5%	0%	13%	0%	0%	0%	5%
NonParticipant	25%	10%	25%	20%	25%	33%	0%	20%	21%	20%

	What have you done so far to address them?									
	ESC Building		Commons		Library		Walker Ave Apts		Total	
	M	C	M	C	M	C	M	C	M	C
Sort the garbage	75%	60%	75%	25%	75%	47%	100%	50%	79%	43%
Increase energy efficiency	75%	0%	75%	0%	75%	40%	100%	50%	79%	0%
Install renewable at home	25%	25%	25%	20%	25%	0%	0%	0%	21%	34%
Show concern (UMBC)	0%	0%	0%	0%	25%	60%	100%	40%	21%	3%
Implement measures (UMBC)	25%	0%	25%	0%	50%	0%	0%	20%	29%	3%
Non participant	25%	10%	25%	25%	25%	33%	0%	20%	21%	22%

	Joint effort to decrease carbon footprint				
	ESC Building	Commons	Library	Walker Ave Apts	Total
	Managment	Managment	Managment	Managment	Managment
yes	50%	50%	25%	100%	50%
no	25%	25%	50%	0%	29%
Non participant	25%	25%	25%	0%	21%

	Joint effort to increase energy efficiency				
	ESC Building	Commons	Library	Walker Ave Apts	Total
	Managment	Managment	Managment	Managment	Managment
yes	75%	75%	50%	100%	71%
no	0%	0%	0%	0%	0%
Non participant	25%	25%	50%	0%	29%

	Are you aware that the light in the library is on all night because of security reason? You think it's reasonable?	
	Library	
	Managment	Consumers
yes and yes	25%	27%
no and yes	0%	0%
yes and no	50%	33%
no and no	0%	7%
Non participant	25%	33%

	Do you know much energy your lab spends per year?				
	ESC Building	Commons	Library	Walker Ave Apts	Total
	Consumers	Consumers	Consumers	Consumers	Consumers
yes	0%	0%	0%	10%	2%
no	95%	80%	67%	70%	80%
Non participant	5%	20%	33%	20%	18%

	Comfortable with temp differences outside inside?				
	ESC Building	Commons	Library	Walker Ave Apts	Total
	Consumers	Consumers	Consumers	Consumers	Consumers
yes	90%	95%	67%	60%	82%
no	10%	5%	7%	40%	12%
Non participant	0%	0%	27%	0%	6%

	Do you forget to turn of the machines and lights when you leave the lab/classroom?			
	ESC Building	Commons	Walker Ave Apts	Total
	Consumers	Consumers	Consumers	Consumers
yes always	40%	30%	20%	25%
yes sometimes	10%	10%	50%	14%
no	40%	35%	10%	25%
Non participant	10%	25%	20%	22%

	Acceptance to change				
	ESC Building	Commons	Library	Walker Ave Apts	Total
	Consumers	Consumers	Consumers	Consumers	Consumers
yes	80%	70%	47%	60%	66%
no	5%	5%	20%	10%	9%
Non participant	15%	25%	33%	30%	25%

	Effectiveness of prompts				
	ESC Building	Commons	Library	Walker Ave Apts	Total
	Consumers	Consumers	Consumers	Consumers	Consumers
yes i think i would	5%	10%	13%	20%	11%
yes me but not everyone	75%	45%	47%	40%	54%
no	5%	20%	7%	10%	11%
Non participant	15%	25%	33%	30%	25%

References

[1] "The World Bank."

[2] G. Hardin, "The Tragedy of the Commons," *Science,* vol. 162, 13 December 1968.

[3] I. Ajzen, "From intentions to actions: a theory of planned behaviour. ," *Control: from cognition to behavior,* pp. 11-39, 1985.

[4] A. Bandura, *Social Learning Theory*: New York: General Learning Press., 1977.

[5] M. A. Antoninus, Ed., *Meditations*. 2002, p.^pp. Pages.

[6] E. S. Geller, Ed., *Handbook of Environmental Psychology*. 2002, p.^pp. Pages.

[7] J. S. Bailey, "Marketing behavior analysis requires different talk " *Journal of Applied Behavior Analysis,* pp. 445-448, 1991.

[8] G. Shippee, "Energy consumption and conservation psycology: A review and conceptual analysis," *Environmental Management,* 1980.

[9] R. A. Winett, "An emerging approach to energy consevation," *Behavioral community psychology,* 1980.

[10] E. S. Geller, "The truth about safety incentives," *Professional Safety,* vol. 41, p. 5, 1996.

[11] E. S. Geller, "Working Safe: How to help people actively care for health and safety," 1998.

[12] B. F. Skinner, "Beyond freedom and dignity," 1971.

[13] J. W. Brehm, "Responses to loss of freedom: A theory of psychological reactance," 1972.

[14] Stern, "Psychological dimensions of global environmental change," *Annual Reviews of Psychology,* pp. 269-302, 1992a.

[15] L. Kruse, "Globale Umweltveranderungen: eine Herausforderung fur die Psychologie [Global environmental changes : a challenge for psychology]," *Psychologische Rundschau,* pp. 81-92, 1995.

[16] L. J. Axelrod and D. R. Lehman, "Responding to environmental concern : what factors guide individual action?," *Journal of Environmental Psychology,* pp. 149-159, 1993.

[17] N. Newhouse, "Implications of attitude and behavior research for environmental conservation," *Journal of Environmental Education,* pp. 26-32, 1990.

[18] I. Ajzen, "The theory of planned behavior," *Organizational Behavior and Human Decision Processes,* pp. 179–211, 1991.

[19] I. Ajzen and M. Fishbein, "Attitude-behaviour relations : a theoretical analysis and review of empirical research.," *Psychological Bulletin,* pp. 888-918, 1977.

[20] F. G. Kaiser, "A general measure of ecological behavior. ," *Journal of Applied Social Psychology,* pp. 395-422, 1998.

[21] F. G. Kaiser and M. Wilson, "Goal-directed conservation behavior: The specific composition of a general performance," *Personality and Individual Differences,* pp. 1531–1544, 2004.

[22] I. Ajzen and M. Fishbein, *Understanding Attitudes and Predicting Social Behavior.*, 1980.

[23] T. M. Stutzman and S. B. Green, "Factors affecting energy consumption: two field tests of the Fishbein-Ajzen model.," *Journal of Social Psychology,* pp. 183-201, 1982

[24] I. Ajzen and T. J. Madden, "Prediction of goal-directed behaviour: attitudes, intentions, and perceived behavioural control.," *Journal of Experimental Social Psychology,* pp. 453-474, 1986.

[25] K. Joreskog and D. Sorbom, *LISREL8: structural equation modeling with the SIMPLIS command language.*: Hillsdale,NJ:Erlbaum., 1993.

[26] P. C. Stern, "Psychology and the science of human–environment interactions.," *American Psychologist,* pp. 523–530, 2000.

[27] H. Scheuthle*, et al.*, "The motivational and instantaneous behavior effects of contexts: Steps towards a theory of goal-directed behavior. ," *Journal of Applied Social Psychology,* pp. 2076–2093, 2005.

[28] F. G. Kaiser and C. Keller, "Disclosing situational constraints to ecological behavior: A confirmatory application of the mixed Rasch model.," *European Journal of Psychological Assessment,* pp. 212-221, 2001

[29] F. G. Kaiser and M. Wilson, "Assessing people's general ecological behavior: A cross-cultural measure.," *Journal of Applied Social Psychology,* pp. 952–978, 2000.

[30] E. S. Geller, "Applied behavior analysis and social marketing: An intergration to preserve the environment," *Journal of Social Issues,* pp. 17-36, 1989.

[31] K. Jay and D. McKenzie-Mohr, "Tools of change: Proven methods for promoting environmental citizenship," *National Round Table on the Environment and the Economy,* 1998.

[32] M.-M. Doug*, et al.*, "Determinants of responsible environmental behavior.," *Journal of Social Issues,* vol. 4, pp. 139-156, 1995.

[33] A. P. Tracy and S. Oskamp, "Relationships among ecologically responsible behaviors," *Journal of Environmental Systems,* pp. 115-126, 1983-1984.

[34] M.-. Mohr*, et al.*, "Evaluation of barriers to participation by individuals in GHG reduction activities " Public Education and Outreach Issue Table Ottawa, Ontario, Canada: Climate Change Secretariat. 1999.

[35] P. D. Doug McKenzie-Mohr. (2006-2010, *Fostering Sustainable Behavior - Community Based Social Marketing*. Available: www.cbsm.com

[36] K. Jay, "Tools of Change," 1996-2009.

[37] G. Greene, "The End of Suburbia: Oil Depletion and the Collapse of the American Dream," ed, 2004.

[38] R. Heinberg's, *Powerdown: Options and Actions for a Post-Carbon World*, 2004.

[39] R. A. Butler. (2009. Available: http://www.mongabay.com/images/commodities/charts/crude_oil.html

[40] *U.S.Energy Information Administration*. Available: http://www.eia.doe.gov/electricity/epm/table5_6_b.html

[41] R. Katzev and T. Wang, "Can commitment change behavior? A case study of environmental actions. ," *Journal of Social Behavior and Personality,* pp. 13-26, 1994.

[42] W. Bachman and R. Katzev, "The effects of non-contingent free bus tickets and personal commitment on urban bus ridership," *Transportation Research,* vol. 16A, pp. 103-108, 1982.

[43] M. S. Pallak*, et al.*, "Commitment and Applied social psychology annual energy conservation. ," *Applied social psychology annual* vol. 1, pp. 235-253, 1980

[44] B. F. Skinner, *Upon further reflection*: Prentice-Hall, 1987.

[45] S. Oskamp, "A sustainable future for humanity?How can psychology help?," *American Psycologist,* 2000.

[46] G. T. a. S. Gardner, P.C., *Environmental problems and human behavior*, 1996.

[47] J. M. Hines*, et al.*, "Analysis and synthesis of research on responsible environmental behavior : a meta-analysis.," *Journal of Environmental Education,* pp. 1-8, 1986/87.

[48] P. C. Stern, "When do people act to maintain common resources? Are formulated psychological question for our times.," *International Journal of Psychology,* pp. 149-158, 1978.

[49] K. E. Lloyd, "Do as I say, not as I do.," *New Zealand Psychologist,* pp. 1-8, 1980.

[50] K. L. Granzin and J. E. Olsen, "Characterizing participants in activities protecting the environment: a focus on donating, recycling, and conservation behaviors.," *Journal of Public Policy & Marketing,* pp. 1-27, 1991.

[51] P. C. Stern, "What psychology knows about energy conservation.," *American Psychologist,* pp. 1224-1232, 1992b.

[52] J. Vining and A. Ebreo, "Predicting recycling behavior from global and specific environmental attitudes and changes in recycling opportunities. ," *Journal of Applied Social Psychology,* pp. 1580-1607, 1992.

[53] K. Foppa*, et al.*, "Was hindert uns daran, zu tun, was wir tun mussen? [What restricts us from doing what we are supposed to do?]," University of Bern, Bern1995.

[54] G. A. Guagnano*, et al.*, "Influences on attitude-behavior relationships- a natural experiment with curbside recycling. ," *Environment and Behavior,* pp. 669-718, 1995.

[55] M. E. Olsen, "Consumers' attitudes toward energy conservation.," *Journal of Social Issues* pp. 108-131, 1981.

[56] J. Vining and A. Ebreo, " Predicting recycling behavior from global and specific environmental attitudes and changes in recycling opportunities.," *Journal of Applied Social Psychology,* pp. 1580-1607, 1992.

[57] U. Fuhrer, . "Sozialpsychologisch fundierter Theorierahmen fur eine Umweltbewusstseinsforschung [Socialpsychological framework for research an environmental concern] ." *Psychologische Rundschau,* pp. 93-103, 1995.

[58] M. J. Rosenberg and C. I. Hovland, "Attitude Organizatio and Change," in *Attitude Organization and Change.*, ed: Yale University Press, 1960, pp. 1-14.

[59] M. P. Maloney and M. P. Ward, "Ecology: let's hear from the people. An objective scale for the measurement of ecological attitudes and knowledge," *American Psychologist,* pp. 583-586., 1973.

[60] M. P. Maloney*, et al.*, "Psychology in action: a revised scale for the measurement of ecological attitudes and knowledge. ," *American Psychologist* pp. 787-790., 1975.

[61] P. C. Smythe and R. C. Brook, "Environmental concerns and actions: a social-psychological investigation.," *Canadian Journal of Behavioural Science* pp. 175-186, 1980.

[62] B. Adler and A. H., "Affect Scale," in *What is Dyscalculia?*, ed, 2001.

[63] R. Langeheine and J. Lehmann, "Ein neuer Blick auf die soziale Basis des Umweltbewusstseins [A new view of the social foundation of environmental concern]," *Zeitschrift fur Soziologie,* pp. 378-384, 1986.

[64] R. G. Dispoto, " Interrelationships among measures of environmental activity, emotionality, and knowledge," *Educational and Psychological Measurement,* pp. 451-459, 1977.

[65] J. Schahn and E. Holzer, "Konstruktion, Validierung und Anwendung von Skalen zur Erfassung des individuellen Umweltbewusstseins Development, validation, and

application of an environmental concern scale," *Zeitschrift fur Differentielle und Diagnostische Psychologie,* pp. 185-204, 1990a.

[66] J. Schahn and E. Holzer, "Studies of individual environmental concern. The role of knowledge, gender, and background variables.," *Environment and Behavioral community psychology,* pp. 767-786, 1990b.

[67] A. E. Auhagen and K. Neuberger, "Verantwortung gegenuberder Umwelt: eine Studie uber umweltbewusstes Handeln [Responsibility toward environment: a study of ecological concerned behaviour]," *Gruppendynamik,* pp. 319-332, 1994.

[68] E. S. Geller, "Evaluating energy conservation programs: is verbal report enough?," *Journal of Consumer Research,* pp. 331-335, 1981.

[69] A. Diekmann and P. Preisendorfer, "Personliches Umweltverhalten: Diskrepanz zwischen Anspruch und Wirklichkeit [Ecological behavior: discrepancy between claim and performance]," *Kolner Zeitschrift fur Soziologie und Sozialpsychologie* pp. 226-251, 1992

[70] A. Grob, "A structural model of environmental attitudes and behaviour," *Journal of Environmental Psychology* pp. 209-220., 1995.

[71] A. P. Sia*, et al.*, "Selected predictors of responsible environmental behavior: ananalysis," *Journal of Environmental Education* pp. 31-40, 1985/86.

[72] I. E. Berger and R. M. Corbin, "Perceived consumer effectiveness and faith in others as moderators of environmentally responsible behaviors.," *Journal of Public Policy & Marketing,* pp. 79-89, 1992

[73] R. E. Dunlap and K. D. VanLiere, "The 'new environmental paradigm': a proposed instrument and preliminary results. ," *Journal of Environmenta Education* vol. 9, 1978

[74] P. C. Stern*, et al.*, "Value orientations, gender, and environmental concern.," *Environment & Behavior* pp. 322-348., 1993.

[75] D. Scott and F. K. Willits, "Environmental attitudes and behavior: a Pennsylvania survey. ," *Environment & Behavior,* pp. 239-260., 1994.

[76] D. Leonard-Barton, "Voluntary simplicity lifestyles and energy conservation," *Journal of Consumer Research,* pp. 243-252, 1981.

[77] K. D. VanLiere and R. E. Dunlap, " . Environmental concern:doesitmakeadifferencehowit'smeasured? EnvironmentandBehavior 13, 651-676," 1981.

[78] T. M. M. Verhallen and W. F. VanRaaij, "Household behavior and the use of natural gas for home heating.," *Journal of Consumer Research* pp. 253-257., 1981.

[79] S. Moore*, et al.*, "A longitudinal study of domestic water conservation behavior. ," *Population and Environment: A Journal of Interdisciplinary Studies* pp. 175-189., 1994

[80] S. Oskamp*, et al.*, "Factors influencing household recycling behavior.," *Environment and Behavior.,* pp. 494-519, 1991.

[81] R. J. Gamba and S. Oskamp, "Factors influencing community residents' participation in commingled curbside recycling programs. ," *Environment and Behavior* pp. 587-612, 1994.

[82] F. M. Lansana, "Distinguishing potential recyclers from nonrecyclers: a basis for developing recycling strategies. ," *Journal of Environmental Education,* pp. 16-23, 1992.

[83] E. Williams, "College students and recycling: their attitudes and behaviors.," *Journal of College Student Development* pp. 86-88, 1991.

[84] G. M. Pickett*, et al.*, " Is there a general conserving consumer? A public policy concern. ," *Journal of Public Policy & Marketing* pp. 234-243, 1993.

[85] K. FLORIAN G. *, et al.*, "ENVIRONMENTAL ATTITUDE AND ECOLOGICAL BEHAVIOUR," *Journal of Environmental Psychology,* pp. 1-19, 1999.

[86] R. H. Weigel*, et al.*, "Specificity of the attitude as a determinant of attitude-behavior congruence ," *Journal of Personality and Social Psychology* pp. 724-728, 1974.

[87] S. M. Smith*, et al.*, "Attitudes and recycling: does the measurement of affect enhance behavioral prediction? ," *Psychology & Marketing* pp. 359-374, 1994.

[88] J. McGuinness*, et al.*, "Attitudinal correlates of recycling behavior.," *Journal of Applied Psychology,* pp. 376-384, 1977.

[89] K. Barker*, et al.*, "Comparison of self-reported recycling attitudes and behaviours with actual behavior. ," *Psychological Reports* pp. 571-577., 1994.

[90] J. Arbuthnot, "The roles of attitudinal and personality variables in the prediction of environmental behaviour and knowledge," *Environment and Behavior,* pp. 217-232, 1977.

[91] J. VanderPligt, "Energy conservation: two easy ways out.," *Journal of Applied Social Psychology,* pp. 3-15, 1985

[92] G. D. Lynne and L. R. Rola, "Improving attitude-behavior prediction models with economic variables: farmer actions toward soil conservation.," *Journal of Social Psychology,* pp. 19-28, 1988.

[93] H. Levenson, "Ecological knowledge and perception of environmental modifiability.," *American Psychologist,* pp. 274-275., 1974.

[94] N. J. Smith-Sebasto and R. W. Fortner, "The environmental action internal control index. ," *Journal of Environmental Education* pp. 23-29, 1994.

[95] S. J. Kantola*, et al.*, "The effects of appraised severity and efficacy in promoting water conservation: an informational analysis.," *Journal of Applied Social Psychology,* pp. 164-182, 1983.

[96] C. J. H. Midden and B. S. M. Ritsema, " The meaning of normative processes for energy conservation.," *Journal of Economic Psychology* pp. 37-55, 1983.

[97] L. J. Axelrod, "Balancing personal needs with environmental preservation: identifying the values that guide decisions in ecological dilemmas.," *Journal of Social Issues* pp. 85-104, 1994

[98] A. Diekmann and A. Franzen, "Umwelthandeln zwischen Moral und Okonomie [Ecological behavior among moral and economy]," University of Bern, Bern, Switzerland1995.

[99] U. Fuhrer and S. Wolfing, "Von den sozialen Grundlagen des Umweltbewusstseins zum verantwortlichen Umwelthandeln: die sozialpsychologische Dimension der Umweltproblematik [From the social basis of environmental concern to responsible ecological action: the social psychological dimension of environmental problems]," Huber, Bern,Switzerland:1997

[100] E. Kals and L. Montada, "Umweltschutz und die Verantwortung der Burger [Pollution control and the responsibility of thecitizens]," *Zeitschrift fur Sozialpsychologie,* pp. 326-337, 1994.

[101] R. B. Huebner and M. W. Lipsey, "The relationship of three measures of locus of control to environmenta activism.," *Basic and Applied Social Psychology,* pp. 45-58, 1981.

[102] M. F. Sherman*, et al.*, "Motorists' locus of control, behavioral intentions regarding gasoline conservation, and confidence in measures to promote it.," *PerceptualandMotorSkills,* pp. 115-118, 1981.

[103] N. A. Busch-Rossnagel and D. J. Weigel, " Implications for college educators of student attitudes to ward energy. ," *Journal of College Student Personnel,* pp. 265-266, 1984.

[104] L. Derksen and J. Gartrell, "The social context of recycling. ," *American Sociological Review,* pp. 434-442, 1993

[105] L. J. Becker*, et al.*, " Relating attitudes to residential energy use.," *Environment and Behavior,* pp. 590-609, 1981.

[106] C. Meseke, "Understanding the environment: a comparison of workers in Germany and Poland.," *Psychology, A Journal of Human Behavior* pp. 1-8, 1994

[107] R. M. Baron and D. A. Kenny, "The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. ," *Journal of Personality and Social Psychology,* pp. 1173-1182, 1986.

[108] I. Seiler, "Umweltbewusstsein als Funktion sozialer Reprasentationen [Ecological concern as a function of social representations]," Master's thesis, University of Bern, Bern, Switzerland, 1994.

[109] M. Amelang and D. Bartussek, "Untersuchungen zur Validitat einer neuen Lugen-Skala [Validity studies of a new lying scale] " *Diagnostica* pp. 103-122, 1970.

[110] B. Wright and G. N. Masters, "Rating scale analysis: Rasch measurement.," 1982.

[111] A. H. Eagly and S. Chaiken, "The psychology of attitudes," 1993

[112] D. T. Campbell, " Social attitudes and other acquired behavioral dispositions.," *Psychology: A study of a science,* vol. 6, pp. 94-172, 1963.

[113] R. M. Dawes and T. L. Smith, "Attitude and opinion measurement.," *Handbook of social psychology,* vol. 1, pp. 509–566, 1985.

[114] J. Vining and A. Ebreo, "Emerging theoretical and methodological perspectives on conservation behavior. ," *Handbook of environmental psychology,* pp. 541-558, 2002.

[115] R. E. Dunlap and J. R. E., "Environmental concern: Conceptual and measurement issues.," *Handbook of environmental sociology* pp. 482–524, 2002.

[116] L. Ross and R. E. Nisbett, "The person and the situation: Perspectives of social psychology. ," 1991.

[117] P. W. Schultz and S. Oskamp, "Effort as a moderator of the attitude–behavio relationship: General environmental concern and recycling.," *Social Psychology Quarterly,* pp. 375–383, 1996.

[118] A. Diekmann and P. Preisendörfer, "Environmental behavior: Discrepancies between aspirations and reality. ," *Rationality and Society,* pp. 79–102, 1998.

[119] F. G. Kaiser and P. W. Schultz, "The attitude–behavior relationship: A test of three models of the moderating role of behavior difficulty. ," ed, 2006.

[120] D. J. Terry and M. A. Hogg, "Group norms and the attitude–behavior relationship: A role for group identification. ," *Personality and Social Psychology Bulletin,* pp. 776–793, 1996.

[121] W. Kempton*, et al.*, "Psychological research for the new energy problems: Strategies and opportunities. ," *American Psychologist* pp. 1213-1223, 1992.

[122] W. Kemptton*, et al.*, "Do consumers know what works in energy conservation?," *What works: Documenting energy conservation in buihtings,* pp. 429-438, 1984.

[123] M.-M. Doug and W. Smith, "Fostering sustainable behavior: An introduction to community-based social marketing " 1999.

[124] J. Austin*, et al.*, "Increasing recycling in office environments: The effects of specific, informative cues. Journal of Applied Behavior Analysis, 26, 247-253. ," 1993.